CHAPTER 4

ELECTRONIC FUEL INJECTION

GENERAL INFORMATION 4.2
SPECIAL TOOLS 4.2
EFI SERVICE NOTES 4.4
FUEL TANK EXPLODED VIEW 4.5
EFI SYSTEM EXPLODED VIEW 4.6
EFI SYSTEM COMPONENT LOCATIONS 4.7
FUEL LINE REMOVAL / INSTALLATION. 4.9
ELECTRONIC FUEL INJECTION 4.10
PRINCIPAL COMPONENTS / INITIAL PRIMING / STARTING PROCEDURE 4.10
ELECTRONIC CONTROL UNIT (ECU). 4.11
ECU SERVICE / REPLACEMENT 4.11
FUEL PUMP 4.12
FUEL SENDER TEST. 4.12
FUEL PUMP TEST 4.13
FUEL PUMP REPLACEMENT 4.14
FUEL TANK REMOVAL 4.17
FUEL TANK INSTALLATION 4.18
FUEL PRESSURE REGULATOR 4.18
FUEL PRESSURE REGULATOR TEST / REPLACEMENT 4.18
FUEL INJECTORS 4.18
FUEL INJECTOR SERVICE / TEST. 4.19
FUEL INJECTOR REPLACEMENT 4.20
TEMP / MANIFOLD ABSOLUTE PRESSURE SENSOR (T-MAP) 4.21
T-MAP SENSOR TEST / REPLACEMENT 4.21
CRANKSHAFT POSITION SENSOR (CPS) 4.21
CPS TEST / REPLACEMENT 4.22
IDLE AIR CONTROL (IAC) 4.23
IAC TEST / REPLACEMENT 4.23
THROTTLE POSITION SENSOR (TPS) 4.24
TPS RESISTANCE TESTS / TPS TESTER / REGULATOR 4.24
TPS REPLACEMENT. 4.25
CAMSHAFT PHASE SENSOR 4.27
CAM PHASE SENSOR TEST / REPLACEMENT 4.27
ENGINE COOLANT TEMPERATURE SENSOR (ECT) 4.28
ECT SENSOR TEST / REPLACEMENT 4.28
IGNITION COIL 4.29
IGNITION COIL / HT LEAD REPLACEMENT / TESTS 4.29
EFI DIAGNOSTICS 4.30
INSTRUMENT CLUSTER TROUBLE CODE DISPLAY. 4.30
EFI TROUBLESHOOTING 4.33
DIGITAL WRENCH™ OPERATION 4.34
SPECIAL TOOLS / DIAGNOSTIC SOFTWARE VERSION 4.34
ECU REPLACEMENT / GUIDED DIAGNOSTIC AVAILABLE 4.34
DIGITAL WRENCH™ COMMUNICATION ERRORS. 4.34
DIGITAL WRENCH™ - DIAGNOSTIC CONNECTOR 4.35
DIGITAL WRENCH™ SERIAL NUMBER LOCATION 4.35
DIGITAL WRENCH™ VERSION AND UPDATE ID 4.35
DIGITAL WRENCH™ UPDATES 4.36
DIGITAL WRENCH™ FEATURE MAP. 4.37
ENGINE CONTROLLER REPROGRAMMING (REFLASH). 4.38
EFI SYSTEM ELECTRICAL OPERATION 4.41

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GENERAL INFORMATION

⚠ WARNING

* Gasoline is extremely flammable and explosive under certain conditions.
* EFI components are under high pressure. Verify system pressure has been relieved before disassembly.
* Never drain the fuel system when the engine is hot. Severe burns may result.
* Do not overfill the tank. The tank is at full capacity when the fuel reaches the bottom of the filler neck. Leave room for expansion of fuel.
* Never start the engine or let it run in an enclosed area. Gasoline powered engine exhaust fumes are poisonous and can cause loss of consciousness and death in a short time.
* Do not smoke or allow open flames or sparks in or near the area where refueling is performed or where gasoline is stored.
* If you get gasoline in your eyes or if you should swallow gasoline, seek medical attention immediately.
* If you spill gasoline on your skin or clothing, immediately wash with soap and water and change clothing.
* Always stop the engine and refuel outdoors or in a well ventilated area.

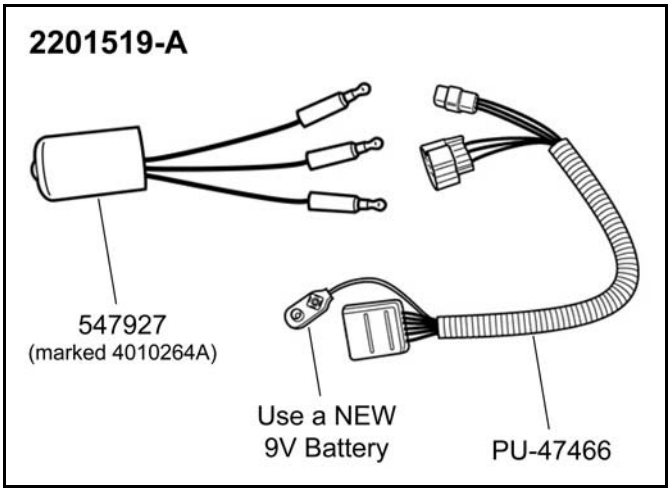
Special Tools

PART NUMBER	TOOL DESCRIPTION	
2201519-A	Throttle Position Sensor (TPS) Tester	
	PU-47466	TPS Tester Wire Harness
	547927	TPS Tester Regulator
PU-43506-A	Fuel Pressure Gauge Kit	
PV-48656	Fuel Pressure Gauge Adaptor	
PU-47063-B	Digital Wrench™ Diagnostic Software (Includes most recent version of software w/ serial number, standard interface cable, USB-Serial Adaptor cable and SmartLink Module Kit)	
PU-47471	Digital Wrench™ SmartLink Module Kit (PU-47470, PU-47469, PU-47468)	
	PU-47470	Digital Wrench™ PC Interface Cable
	PU-47469	Digital Wrench™ Vehicle Interface Cable
	PU-47468	Digital Wrench™ SmartLink Module

SPX Corp: 1-800-328-6657 or http://polaris.spx.com/

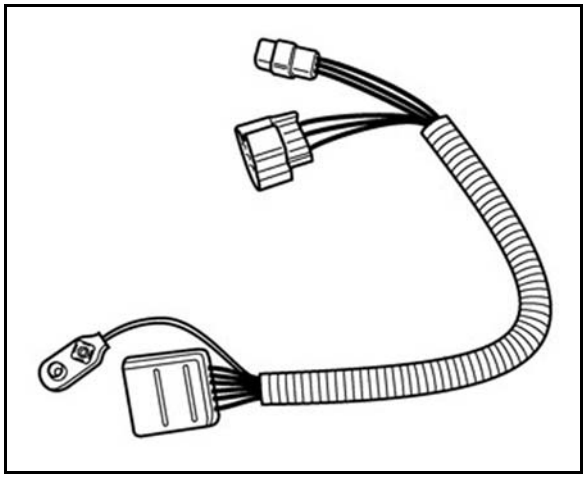
Throttle Position Sensor (TPS) Tester - 2201519-A

This tester allows the use of a digital multi-meter to test TPS function as well as perform the TPS adjustment procedure.



TPS Tester Wire Harness - PU-47466

This TPS wire harness is part of 2201519-A and incorporates two TPS connectors to allow for multi-use applications.



NOTE: Voltage Regulator (547927) is required if using TPS Tester Wire Harness (PU-47466). You may already have this regulator (marked 4010264) as part of another TPS Tester Kit. If you do not have this regulator, you must order one from SPX at 1-800-328-6657.

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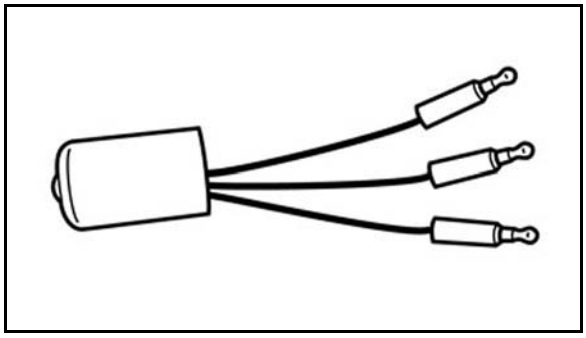
TPS Tester Regulator - 547927

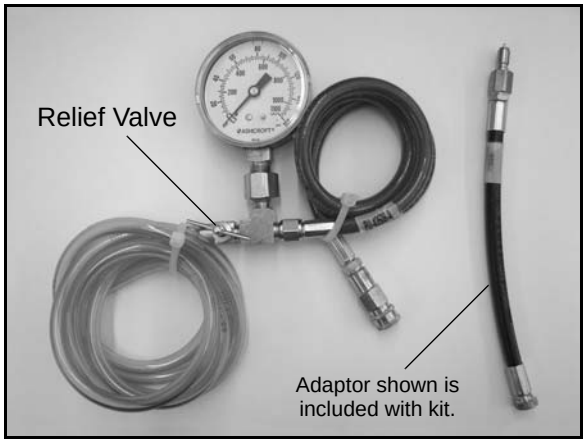
This tester regulator is part of 2201519-A. It regulates the 9 volt battery voltage to a 5 volt reference input, required when using the TPS Tester Wire Harness (PU-47466).



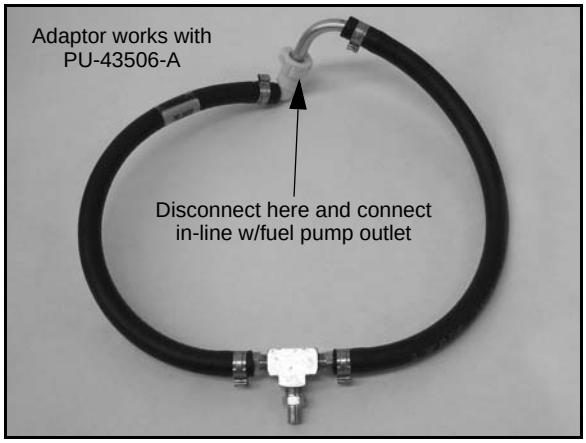
NOTE: You may already have this regulator (marked 4010264) as part of another TPS Tester Kit. If you do not have this regulator, you must order one from SPX at 1-800-328-6657.

Fuel Pressure Gauge Kit - PU-43506-A

IMPORTANT: The EFI fuel system remains under high pressure, even when the engine is not running. Before attempting to service any part of the fuel system, pressure must be relieved (if applicable). The Fuel Pressure Gauge Kit has an integrated pressure relief valve that can be used to bleed off pressure once you have completed the fuel pressure test.



Fuel Pressure Gauge Adaptor - PV-48656



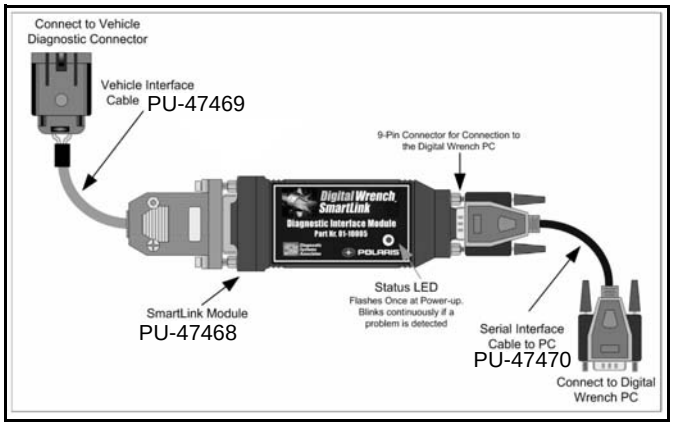
Digital Wrench™ Diagnostic Software - PU-47063-B

This dealer-only software installs on laptop computers equipped with a CD drive and is designed to replace multiple shop tools often used to test EFI components. It also includes step-by-step diagnostic procedures to aid technician repair and troubleshooting.

IMPORTANT: If the PC you are using is not equipped with a 9-pin serial port, a USB to serial port adaptor will be necessary. A USB to serial port adaptor can be purchased through DSA at: www.diagsys.com

Digital Wrench™ SmartLink Module Kit - PU-47471

This module kit contains the necessary cables and hardware to communicate between the vehicle ECU and the Digital Wrench™ diagnostic software. Polaris dealers can also order the following kit components separately: **SmartLink Module PU-47468**, **Vehicle Interface Cable PU-47469** and **PC Interface Cable PU-47470**. This module kit is used on all 8 pin connector-based Polaris EFI systems. This kit is available to Polaris dealers through our tool supplier SPX at http://polaris.spx.com or 1-800-328-6657.



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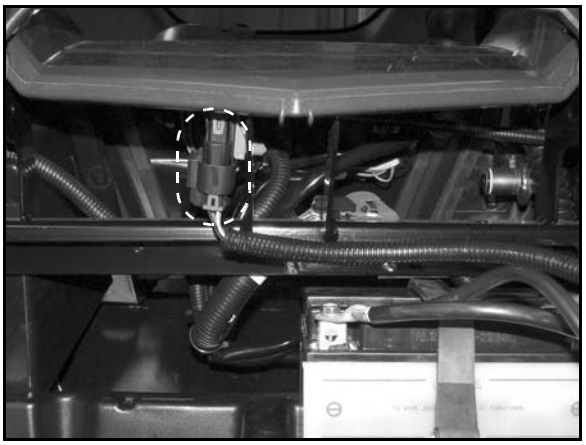
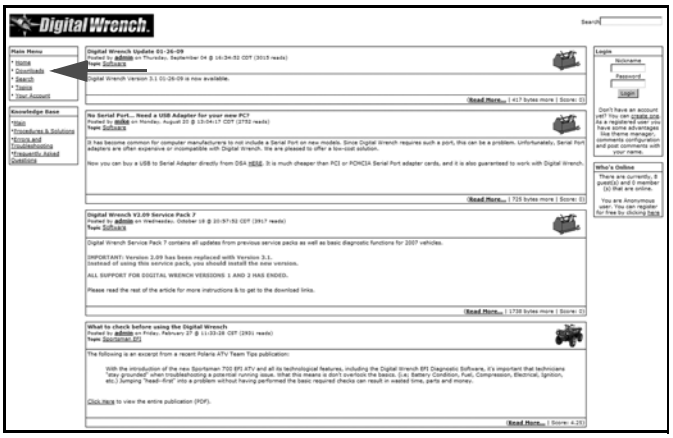
Digital Wrench™ - Diagnostic Connector

Located under the hood connected to a sealed plug.

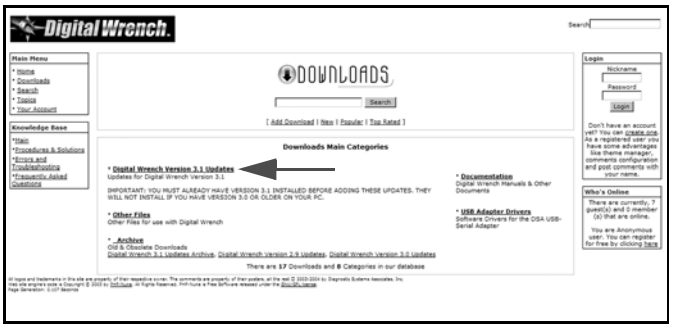


Digital Wrench™ - Download Website

Located at: www.polaris.diagsys.com



Download Digital Wrench™ Updates:



IMPORTANT: For the most recent information on Digital Wrench™ software and update downloads please visit the website: www.polaris.diagsys.com

EFI Service Notes

- For more convenient and accurate testing of EFI components, it is recommended dealers utilize the Digital Wrench™ Diagnostic Software (dealer only), or testing may be done manually using the procedures provided.
- **80% of all EFI problems are caused by wiring harness connections.**
- For the purpose of troubleshooting difficult running issues, a known-good ECU from another *RANGER* 800 EFI of the same model and year may be used without damaging system or engine components.
- Never attempt to service any fuel system component while engine is running or ignition switch is "on."
- Cleanliness is essential and must be maintained at all times when servicing or working on the EFI system. Dirt, even in small quantities, can cause significant problems.
- Do not use compressed air if the system is open. Cover any parts removed and wrap any open joints with plastic if they will remain open for any length of time. New parts should be removed from their protective packaging just prior to installation.
- Clean any connector before opening to prevent dirt from entering the system.
- Although every precaution has been taken to prevent water intrusion failure, avoid direct water or spray contact with system components.
- Do not disconnect or reconnect the wiring harness connector to the control unit or any individual components with the ignition "on." This can send a damaging voltage spike through the ECU.
- Do not allow the battery cables to touch opposing terminals. When connecting battery cables attach the positive (+) cable to positive (+) battery terminal first, followed by negative (-) cable to negative (-) battery terminal.
- Never start the engine when the cables are loose or poorly connected to the battery terminals.
- Never disconnect battery while engine is running.
- Never use a battery boost-pack to start the engine.
- Do not charge battery with key switch "on."
- Always disconnect negative (-) battery cable lead before charging battery.
- Always unplug ECU from the wire harness before performing any welding on the unit.

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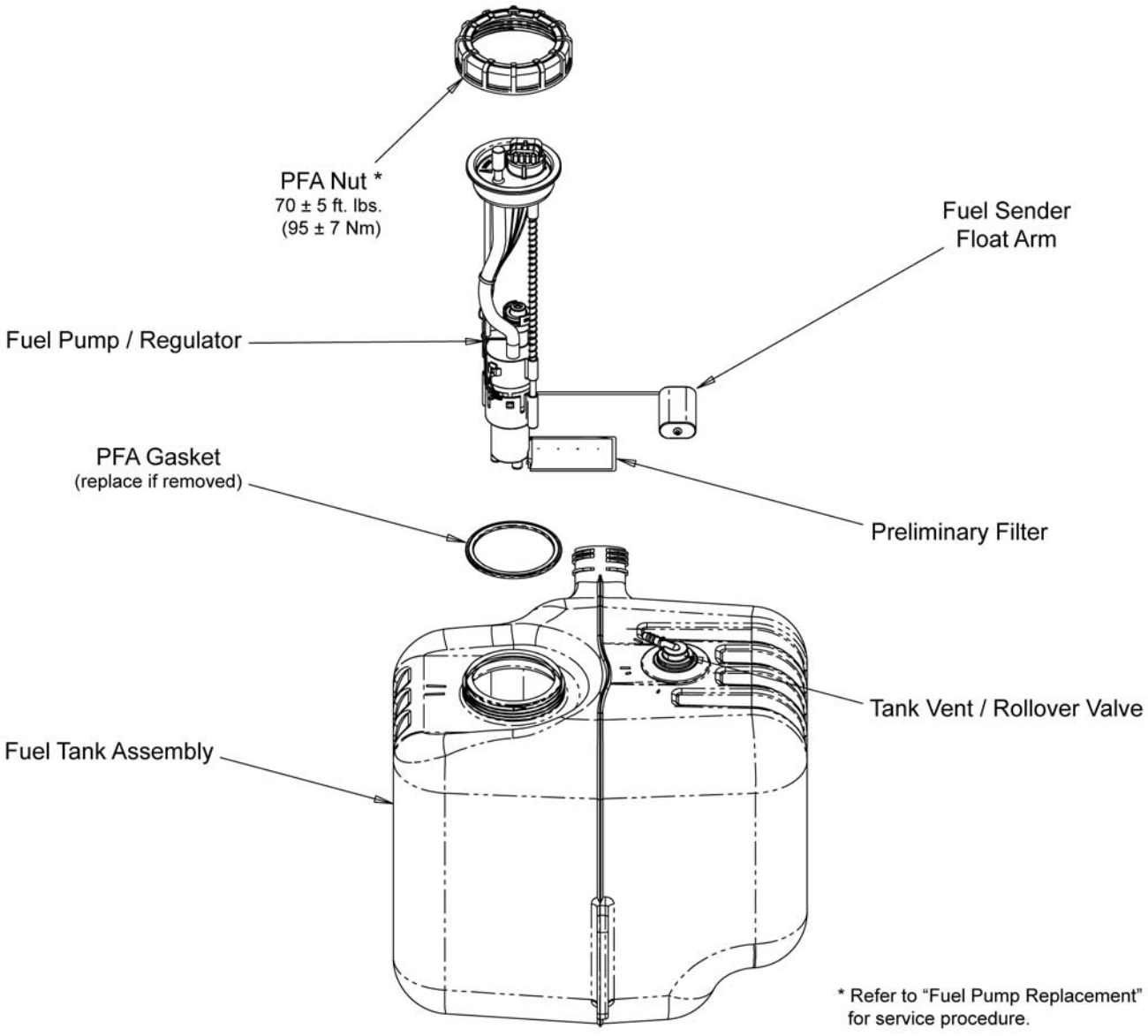
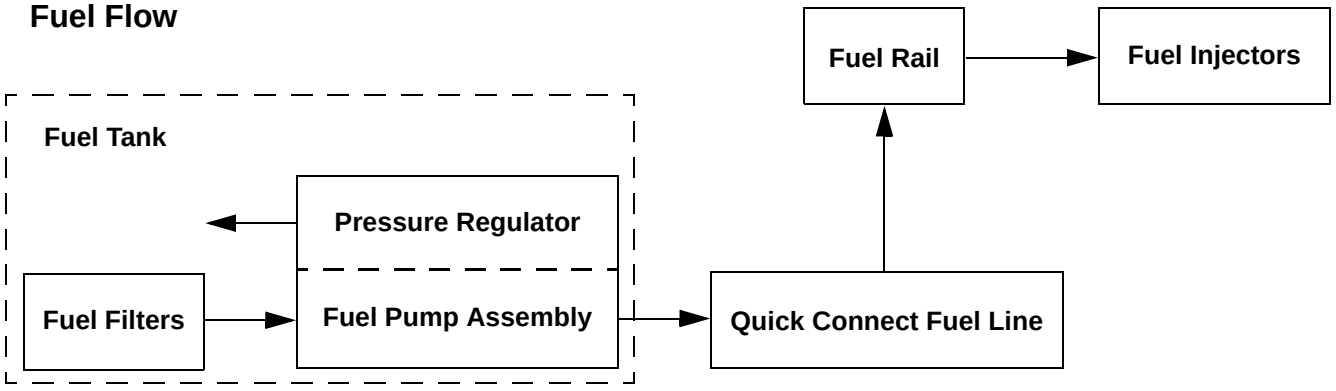
Fuel Tank Exploded View



Fuel Flow



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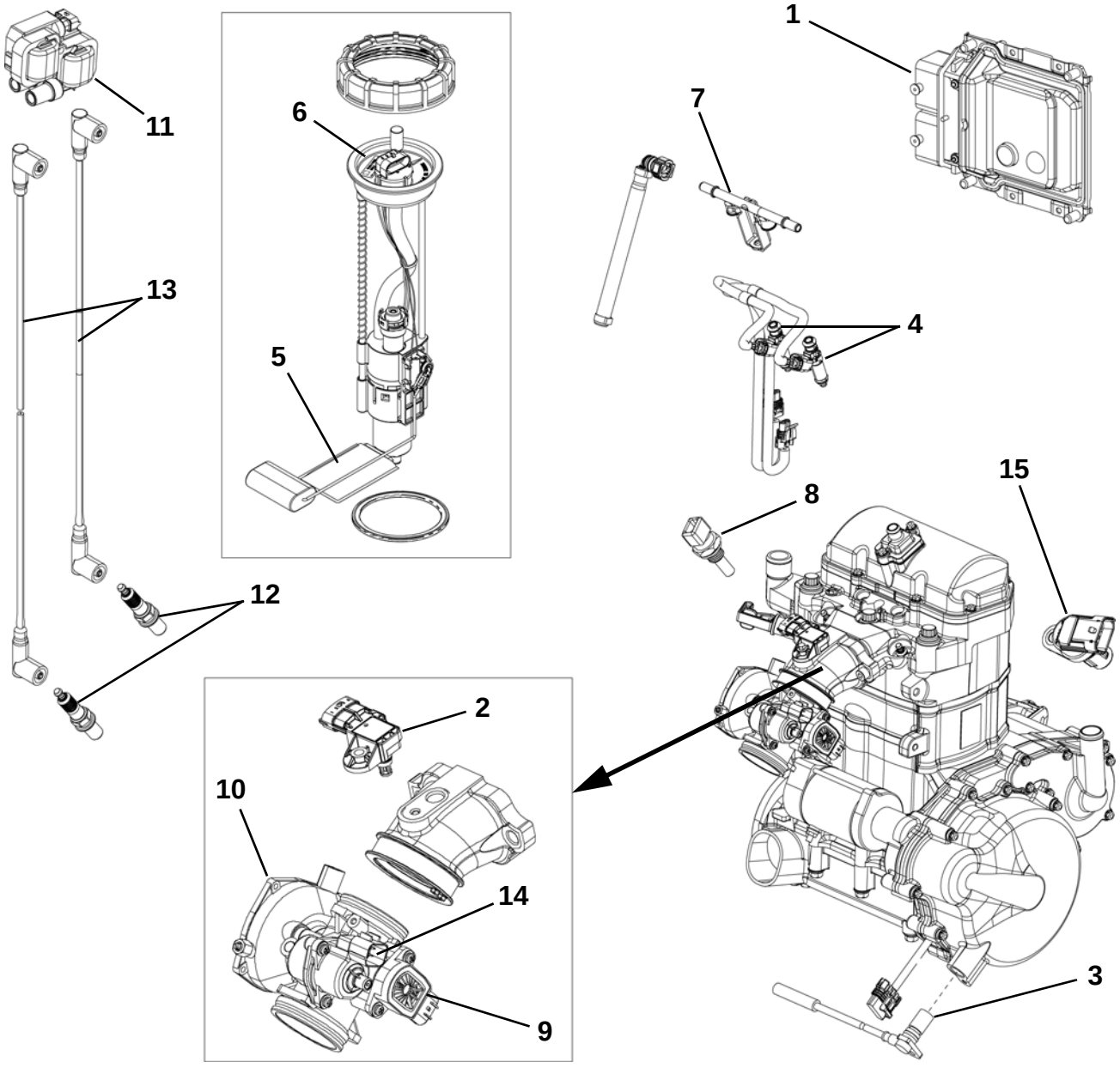
EFI System Exploded View

1. Electronic Control Unit (ECU) 2. Temperature / Manifold Absolute Pressure Sensor (T-MAP) 3. Crankshaft Position Sensor (CPS) 4. Fuel Injectors 5. Fuel Filter 6. Fuel Pump / Regulator / Fuel Level Sender (located in fuel tank) 7. Fuel Rail 8. Engine Coolant Temperature Sensor (ECT) 9. Throttle Position Sensor (TPS) 10. Throttle Body 11. Ignition Coil 12. Spark Plugs	13. Spark Plug Wires 14. Idle Air Control (IAC) 15. Camshaft Phase Sensor



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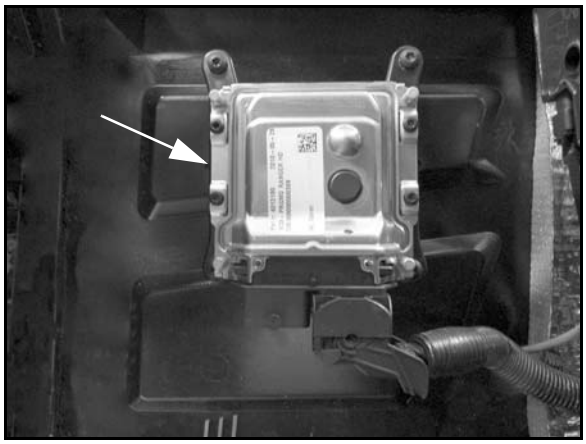
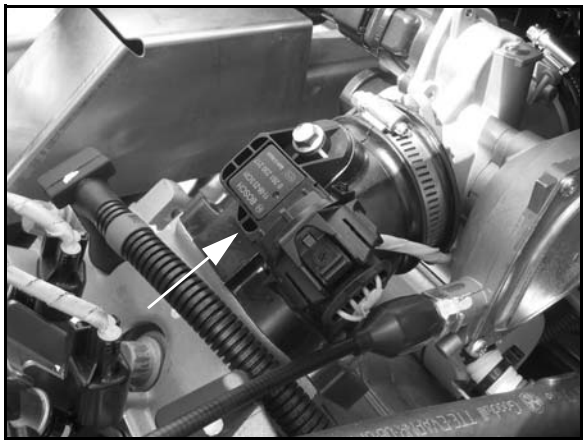
EFI System Component Locations

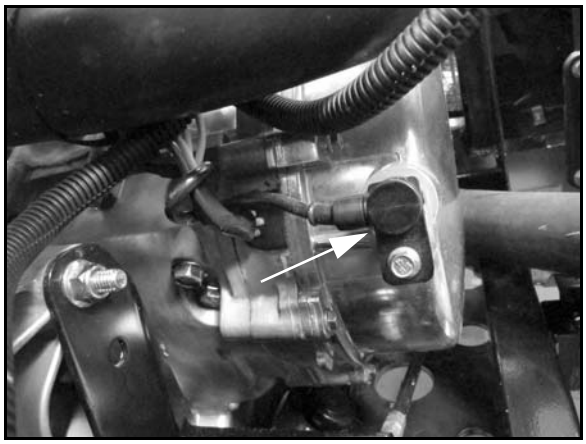
1. **Electronic Control Unit (ECU)**
   - Located under the seat on the drivers side, mounted to the rear floor panel.



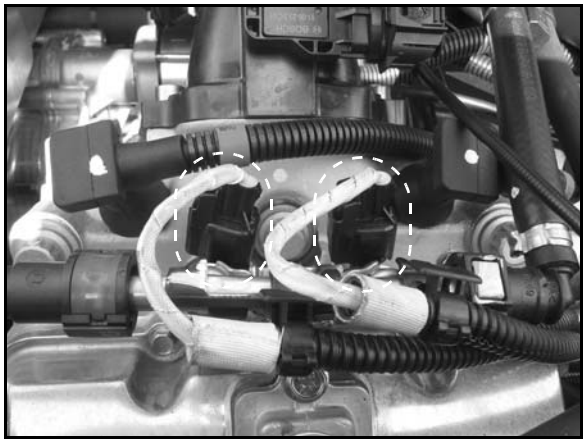
2. **Temperature and Manifold Absolute Pressure Sensor (T-MAP)**
   - Located in the rubber intake boot between the throttle body and the cylinder head.



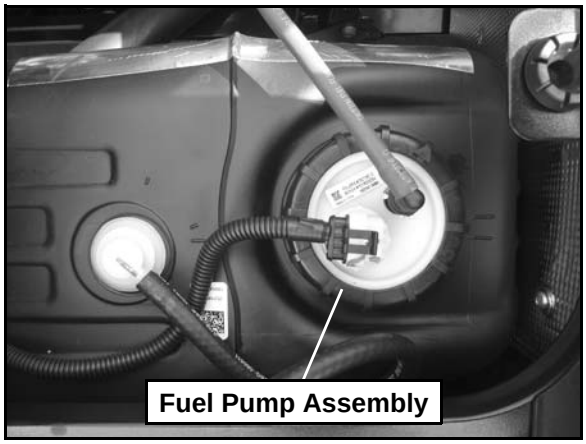
3. **Crankshaft Position Sensor (CPS)**
   - Located in the magneto cover on the right-hand side of the engine.

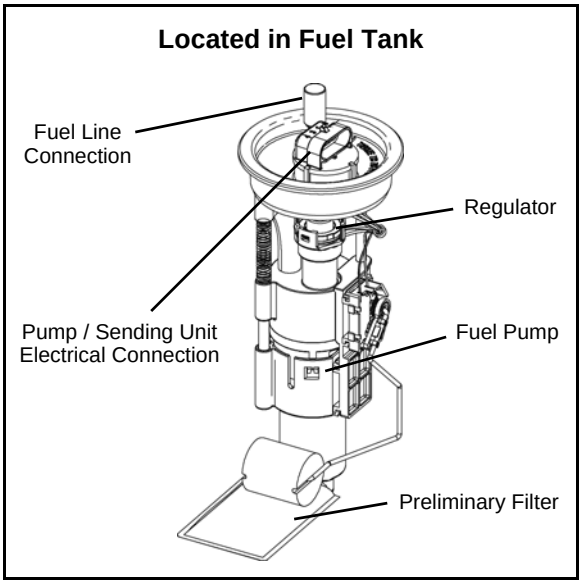


4. **Fuel Injectors / Fuel Rail**
   - Attached to the fuel rail located in the intake track of the cylinder head.



5. **Fuel Pump / Regulator / Fuel Gauge Sender Assembly**
   - Located under the seat base on the passenger side. Located in the fuel tank as an assembly.





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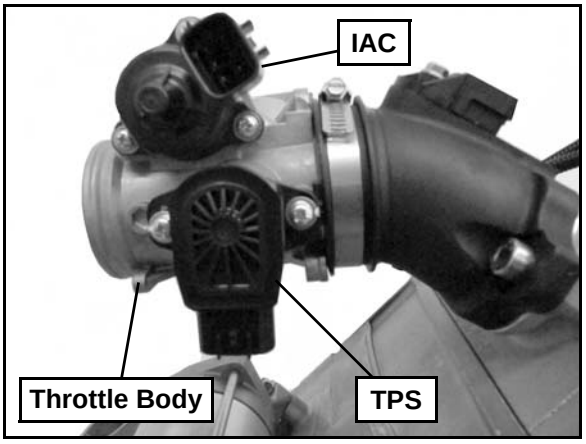
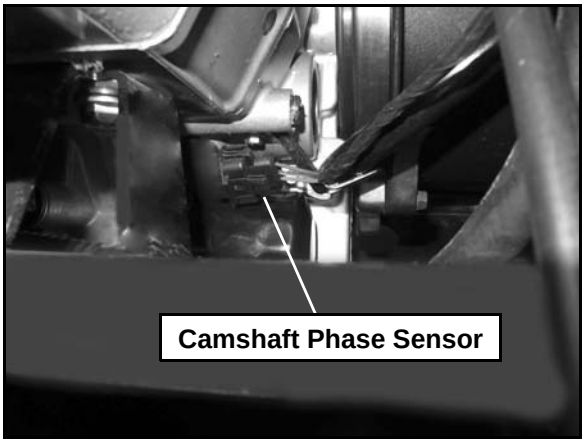
6. **Throttle Body**
   - Located between the rubber air box boot and rubber cylinder head adaptor.

7. **Throttle Position Sensor (TPS)**
   - Located on the right-hand side of the throttle body below the IAC motor.

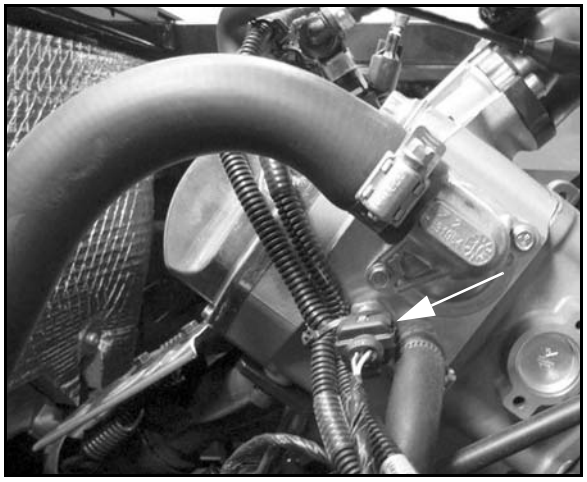
8. **Idle Air Control Motor (IAC)**
   - Located on the upper right-hand side of the throttle body above the TPS.



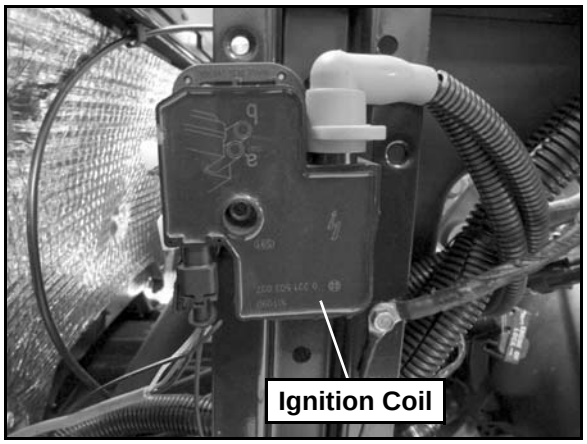
9. **Camshaft Phase Sensor**
   - Located in the engine block above the oil filter.



10. **Engine Coolant Temperature Sensor (ECT)**
    - Located in the cylinder head next to the thermostat housing.



11. **Ignition Coil**
    - Located under the seat on the drivers side, mounted on the vertical frame member.



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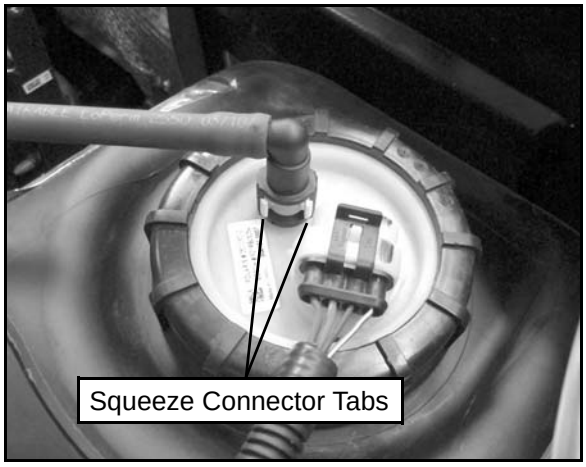
Fuel Line Removal / Installation

RANGER EFI models use quick connect fuel lines. Refer to the steps for fuel line removal / installation:

> **⚠ CAUTION**
>
> Verify fuel system has been depressurized before performing this procedure.

1. Thoroughly clean the connector and place a shop towel around the fuel line to catch any dripping fuel.
2. Squeeze the connector tabs together and slide the white retainer forward.



3. Lift up on the fuel line to remove from the fuel pump outlet.
4. To install the line, verify the connector and fuel pump outlet are clean and free of debris.
5. Place the connector end over the fuel pump outlet and push the white retainer and tabs back into place.
6. Repeat this process to remove the fuel line from the fuel rail.

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ELECTRONIC FUEL INJECTION

Principal Components

The Electronic Fuel Injection (EFI) system is a complete engine fuel and ignition management design. This system includes the following principal components:

- Fuel Pump
- Fuel Rail
- Fuel Line(s)
- Fuel Filter(s)
- Fuel Injectors
- Pressure Regulator
- Throttle Body / Intake Manifold
- Engine Control Unit (ECU)
- Ignition Coils
- Engine Coolant Temperature Sensor (ECT)
- Throttle Position Sensor (TPS)
- Crankshaft Position Sensor (CPS)
- Temperature and Manifold Absolute Pressure Sensor (T-MAP)
- Camshaft Phase Sensor
- Idle Air Control Motor (IAC)
- Wire Harness Assembly
- Check Engine Light

EFI Operation Overview

The EFI system is designed to provide peak engine performance with optimum fuel efficiency and lowest possible emissions. The ignition and injection functions are electronically controlled, monitored and continually corrected during operation to maintain peak performance.

The central EFI component is the Bosch Electronic Control Unit (ECU) which manages system operation, determining the best combination of fuel mixture and ignition timing for the current operating conditions.

An in-tank electric fuel pump is used to move fuel from the tank through the fuel line, to the fuel rail. The in-tank fuel pressure regulator maintains a system operating pressure and returns any excess fuel back into the tank. At the engine, fuel is fed through the fuel rail and into the injectors, which inject into the intake ports. The ECU controls the amount of fuel by varying the length of time that the injectors are "on." This range can vary depending on fuel requirements. The controlled injection of the fuel occurs every other crankshaft revolution, or once for each 4-stroke cycle. The total amount of fuel needed for one firing of a cylinder is injected during each cycle. When the intake valve opens, the fuel/air mixture is drawn into the combustion chamber, ignited and burned.

The ECU controls the amount of fuel being injected and the ignition timing by monitoring the primary sensor signals for intake air temperature, manifold absolute pressure (load), engine temperature, speed (RPM), camshaft position and throttle position. These primary signals are compared to the programming in the ECU computer chip, and the ECU adjusts the fuel delivery and ignition timing to match the values.

During operation, the ECU has the ability to re-adjust temporarily; providing compensation for changes in overall engine condition and operating environment, so it will be able to maintain the ideal air/fuel ratio.

During certain operating periods such as cold starts, warm up, acceleration, etc., a richer air / fuel ratio is automatically calculated by the ECU.

Initial Priming / Starting Procedure

NOTE: The injection system must be purged of all air prior to the initial start up, and / or any time the system has been disassembled.

If the EFI system is completely empty of fuel or has been disassembled and repaired:

1. Cycle the key switch from “OFF” to “ON” 6 times, waiting for approximately 3 seconds at each “ON” cycle to allow the fuel pump to cycle and shut down.
2. Once step 1 is completed, turn the key switch to “START” until the engine starts or 5 seconds has passed.
3. If the engine failed to start, repeat step 1 for 2 more cycles and attempt to start the engine.

If the engine fails to start, a problem may still exist, and should be diagnosed.

NOTE: Accurate testing of EFI components is recommended utilizing the Digital Wrench™ Diagnostic Software (dealer only).

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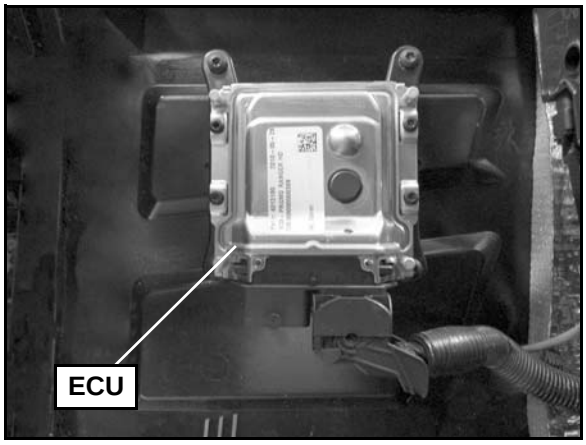
ELECTRONIC CONTROL UNIT (ECU)

Operation Overview

The ECU is the brain or central processing computer of the entire EFI fuel/ignition management system. During operation, sensors continuously gather data which is relayed through the wiring harness to input circuits within the ECU. Signals to the ECU include: ignition (on/off), crankshaft position and speed (RPM), camshaft position (MAG/PTO), throttle position, engine coolant temperature, intake air temperature, intake manifold absolute pressure and battery voltage. The ECU compares the input signals to the programmed maps in its memory and determines the appropriate fuel and spark requirements for the immediate operating conditions. The ECU then sends output signals to set the injector duration and ignition timing.



During operation, the ECU continually performs a diagnostic check of itself, each of the sensors, and system performance. If a fault is detected, the ECU turns on the “Check Engine” light in the speedometer and stores the fault code in its fault memory. Depending on the significance or severity of the fault, normal operation may continue, or "Fail-Safe" operation (slowed speed, richer running) may be initiated. A technician can determine the cause of the “Check Engine” light by referencing the “Instrument Cluster Trouble Code Display” and “Diagnostic Trouble Code Table” or by using Digital Wrench™. The ECU requires a minimum of 7.0 volts to operate. The memory in the ECU is operational the moment the battery cables are connected.

To prevent engine over-speed and possible failure, an RPM limiting feature is programmed into the ECU. If the maximum RPM limit is exceeded, the ECU suppresses the injection signals, cutting off the fuel flow and retards the ignition timing. This process repeats it self in rapid succession, limiting operation to the preset maximum.

Engine RPM Limit: **6500 RPM**

ECU Service

Never attempt to disassemble the ECU. It is sealed to prevent damage to internal components. Warranty is void if the case is opened or tampered with in any way.

All operating and control functions within the ECU are pre-set. No internal servicing or readjustment may be performed. If a problem is encountered, and you determine the ECU to be faulty, contact the Polaris Service Department for specific handling instructions. Do not replace the ECU without factory authorization.

The relationship between the ECU and the throttle position sensor (TPS) is very critical to proper system operation. If the TPS is faulty, or the mounting position of the TPS to the throttle body is altered, the TPS must be adjusted.

For the purpose of troubleshooting, a known-good ECU from another Polaris ***RANGER*** 800 EFI of the same model may be used without system or engine component damage.

ECU Replacement

1. Remove the (4) retaining screws holding the ECU.
2. With the ignition turned off, disconnect the wire harness from the ECU.
3. To install, reverse the procedures and tighten screws to specification.

= **T**
ECU Retaining Screws: **10 in. lbs. (1.1 Nm)**

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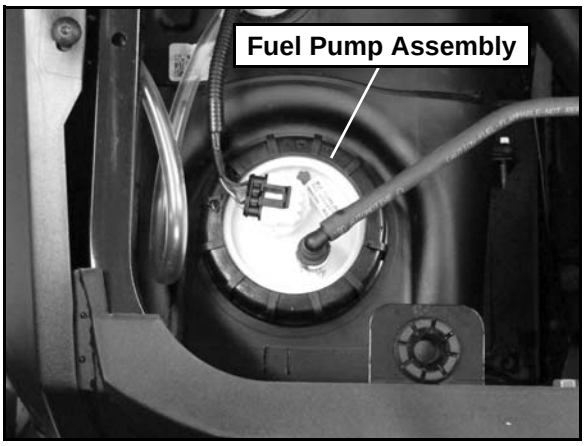
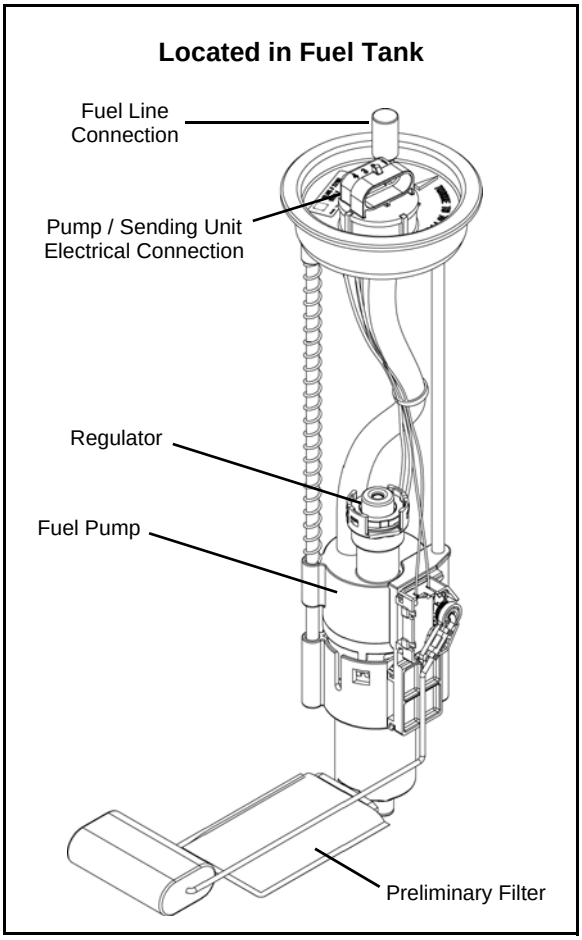
FUEL PUMP

Operation Overview

An electric fuel pump assembly is used to transfer fuel to the EFI system from inside the fuel tank. This assembly includes the fuel pump, fuel filters, regulator and fuel gauge sender. The pump is rated for a minimum output of 25 liters per hour at 45 +/- 2 psi and has two non-serviceable fuel filters.





When the key switch is turned to "ON", the ECU activates the fuel pump, which pressurizes the system for start-up.

The ECU switches off the pump preventing the continued delivery of fuel in these instances:

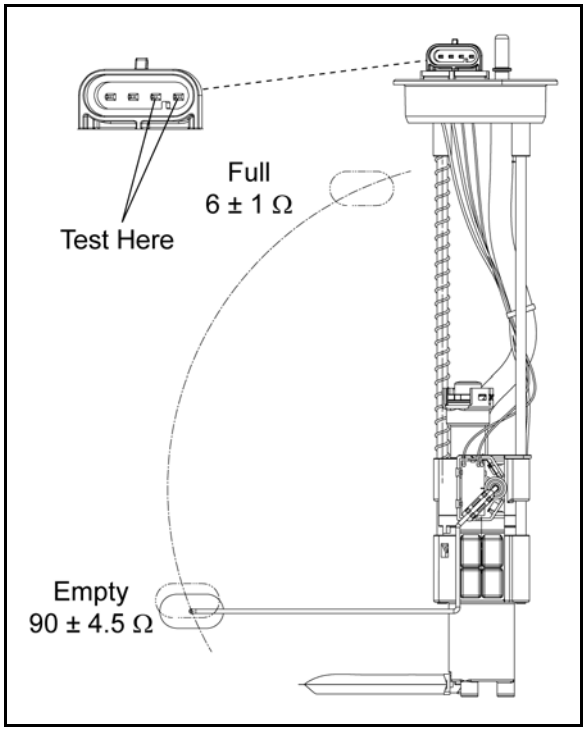
- If the key switch is not promptly turned to the "start" position.
- If the engine fails to start.
- If the engine is stopped with the key switch "on" (as in the case of an accident).

In these situations, the “check engine” light will turn on, but turn off after 4 cranking revolutions if system function is OK. Once the engine is running, the fuel pump remains on.

Fuel Sender Test

If the fuel gauge reading on the instrument cluster is not working, or if the display reading differs in large comparison to the fuel in the tank, perform a resistance test on the fuel sender.

Disconnect the fuel pump / sending unit connection and measure the resistance (see chapter 10 “Fuel Sender Testing”). If out of specification, replace the fuel pump assembly.



Fuel Sender Resistance Specifications:
Full: 6 ± 1 Ω
Empty: 90 ± 4.5 Ω

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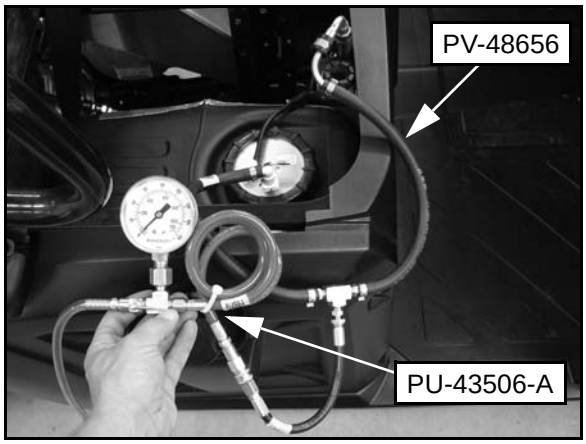
Fuel Pump Test

If a fuel delivery problem is suspected, make certain the fuel pump filters are not plugged, that the pump is being activated through the ECU, all electrical connections are properly secured, the fuses are good, and a minimum of 7.0 volts is being supplied. If during starting the battery voltage drops below 7.0 volts, the ECU will fail to operate the system.

⚠ WARNING

Fuel is extremely flammable and may cause severe burns, injury, or death.
Do not use any device that produces a flame or electrical devices that may spark around fuel or fuel vapors.

1. Remove the seat base to access the fuel pump.
2. Cover the fuel line connection with a shop towel and disconnect the fuel line from the fuel pump.
3. Install the Fuel Pressure Gauge Adaptor (PV-48656) in-line between the fuel pump outlet and fuel line.
4. Connect the hose from the Fuel Pressure Gauge Kit (PU-43506-A) to the test valve on the Fuel Pressure Gauge Adaptor (PV-48656). Route the clear hose into a portable gasoline container or the vehicle's fuel tank.

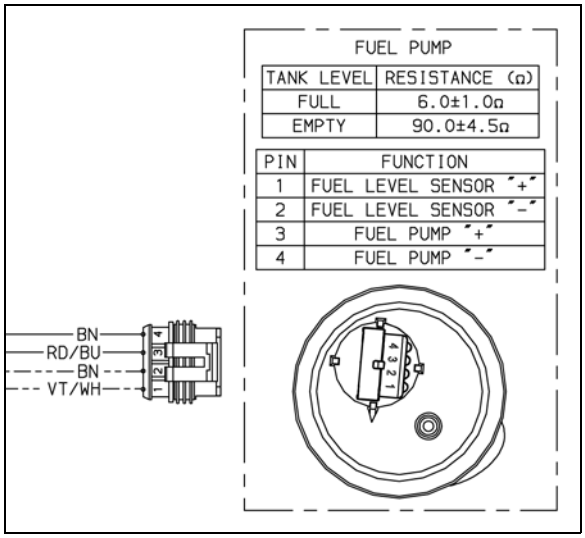


5. Turn on the key switch to activate the pump and check the system pressure on the gauge. If system pressure of 45 ± 2 psi is observed, the ignition switch, ECU, fuel pump, and pressure regulator are working properly. Turn the key switch off and depress the valve button on the tester to relieve the system pressure.

Fuel Pump Pressure: 45 ± 2 psi.

NOTE: If the fuel pressure is out of specification, replace the fuel pump assembly.

6. If the pump did not activate (Step 5), disconnect the harness connector from the fuel pump. Connect a DC voltmeter across terminals "3" and "4" in the plug on the vehicle fuel pump harness. Turn on the key switch and observe voltage to ensure a minimum of 7 volts is present.



NOTE: If the voltage was below 7 VDC, test the battery, ignition switch, relay(s), wiring harness and ECU.

7. If the reading is between 7 and 14 volts, turn key switch off and connect an ohmmeter between terminals "3" and "4"' at the white fuel pump connector to check for continuity within the fuel pump.

NOTE: If there was no continuity between the pump terminals, replace the fuel pump assembly.

8. If voltage at the plug was within the specified range, and there was continuity across the pump terminals, reconnect the plug to the fuel pump, making sure you have a clean connection. Turn on the key switch and listen for the pump to activate.

NOTE: If the pump starts, repeat steps 3, 4 and 5 to verify correct pressure.

9. If the pump still does not operate, check for correct ECU operation by plugging in a known-good ECU of the same model.

NOTE: If the pump still does not operate, replace the fuel pump assembly.

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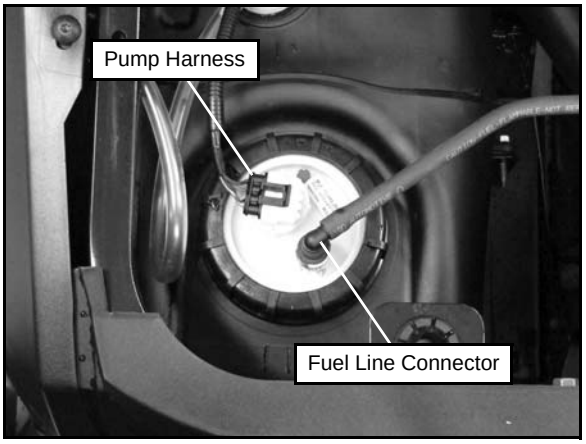
Fuel Pump Replacement

WARNING

Always wear safety goggles when working with high pressure or flammable fluids. Failure to do so could result in serious injury or complications.

1. Remove the lower seat base to access the fuel pump.
2. Ensure that static has been discharged by touching a ground source such as the engine or frame.
3. Disconnect the fuel pump electrical harness.



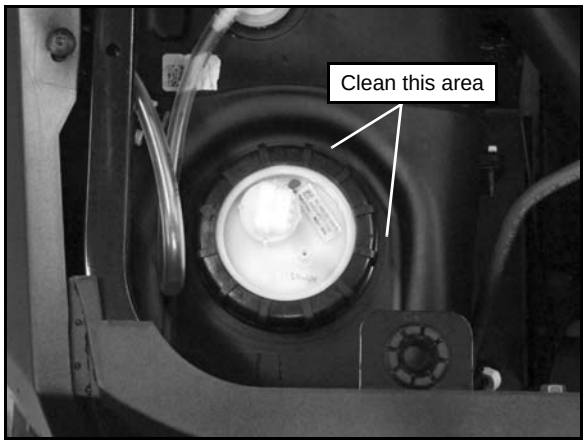
4. While holding a shop towel over the fuel line connector, disconnect the quick connect fuel line from the fuel pump.

CAUTION

It is possible for pressurized fuel to be present when disconnecting the fuel line.
It is recommended to allow the vehicle to sit for a period of one hour after shutting off the engine before servicing the fuel pump. This allows the exhaust to cool and fuel pressure to drop.

NOTE: A small amount of fuel may come out of the fuel line or tank. Properly drain fuel into a suitable container.

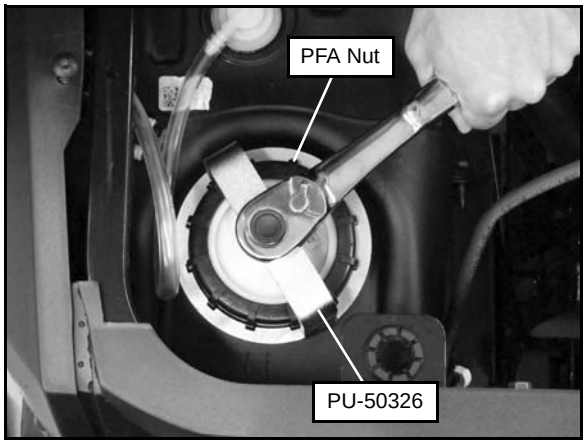
5. Be sure the top of the fuel tank is clean. If it requires cleaning, hand wash the top of the tank to ensure no debris will enter the fuel system when the fuel pump is removed.



CAUTION

Failure to clean area around fuel pump may lead to debris entering the fuel tank during service. Excessive debris in fuel tank may cause premature wear of fuel pump and/or clogging of internal fuel filters.

6. Place the Fuel Pump Service Tool (PU-50326) over the fuel pump PFA nut. Using a 1/2” drive ratchet or breaker bar, loosen and remove the PFA nut. Discard the PFA nut.



NOTE: Apply downward force on the fuel pump flange while removing the fuel pump PFA nut.

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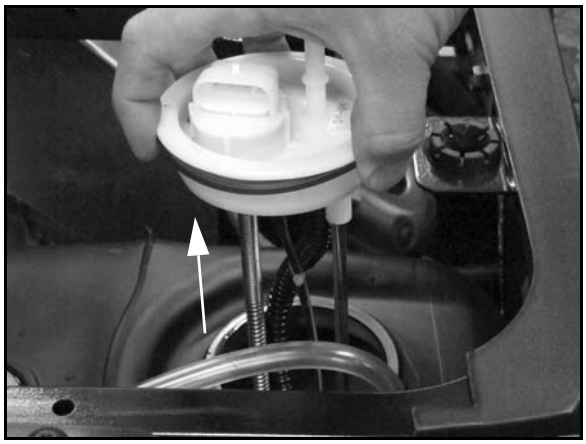
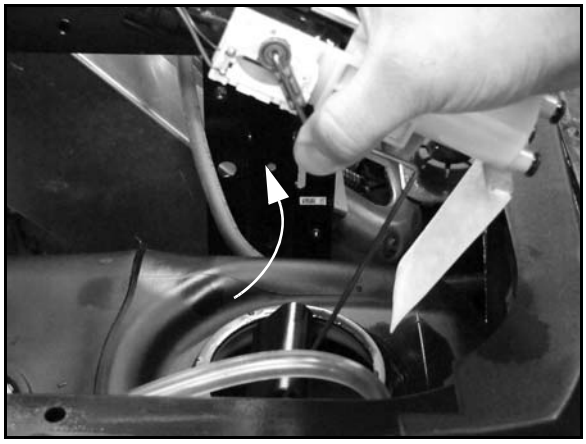
7. Carefully lift the fuel pump out of the fuel tank. As the fuel pump assembly is being removed, be aware of float arm and pump pre-filter. Hold the float arm to the pump body as you lift and tilt the pump to ensure that the float arm is not bent when removed from the tank.





8. Transfer old fuel pump to a suitable container capable of safely holding fuel. The fuel pump will retain some fuel.

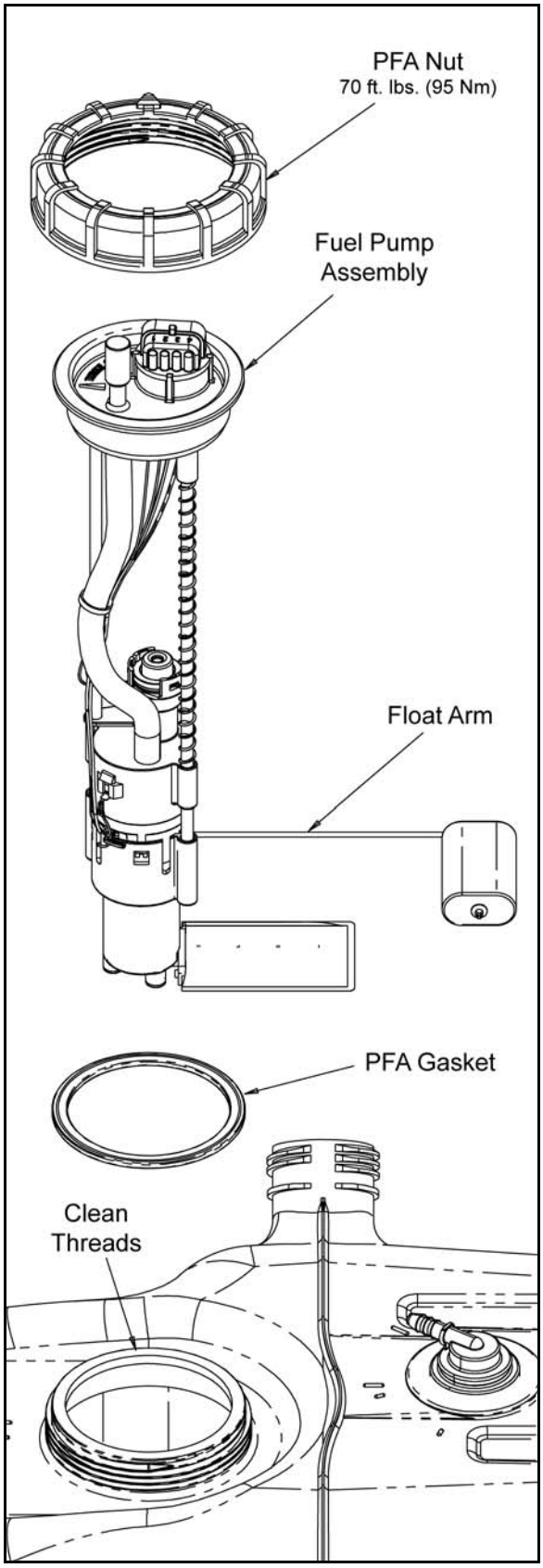
9. Inspect the inside of the fuel tank for debris (may require flashlight and mirror). If debris like mud or sand is present, fuel tank should be flushed and cleaned out prior to installation of new fuel pump assembly.

IMPORTANT: It is recommended to remove the fuel tank from the vehicle and rinse it with a small amount of clean fuel. Do not use water or any other chemicals to remove debris.

10. Remove new fuel pump assembly, gasket and PFA nut from packaging. Use care not to bend float arm during un-packaging. Do not lift or carry fuel pump assembly by the float arm.

11. Use cleaning wipes provided to clean fuel tank surface and threads. Remove all debris, grease and oil. Allow surfaces to dry completely.

12. Install new PFA gasket onto fuel pump assembly using care not to damage gasket or bend float arm.



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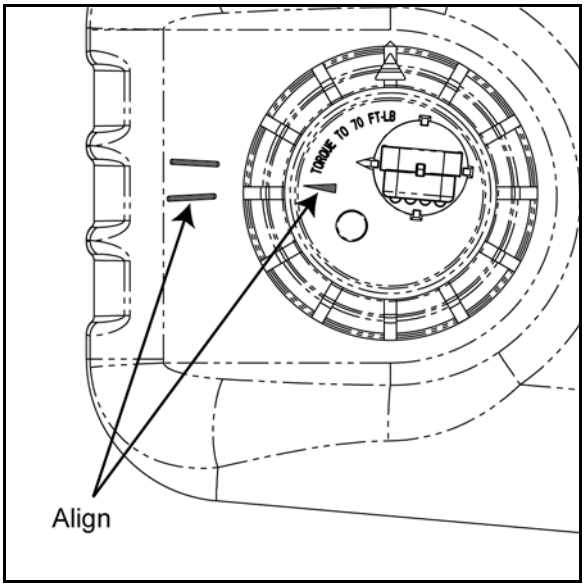
13. Install fuel pump into fuel tank, hold float arm to the pump body and tilt assembly to ensure float arm does not get caught or bent during installation.

14. Gently push down on fuel pump flange ensuring flange is centered.

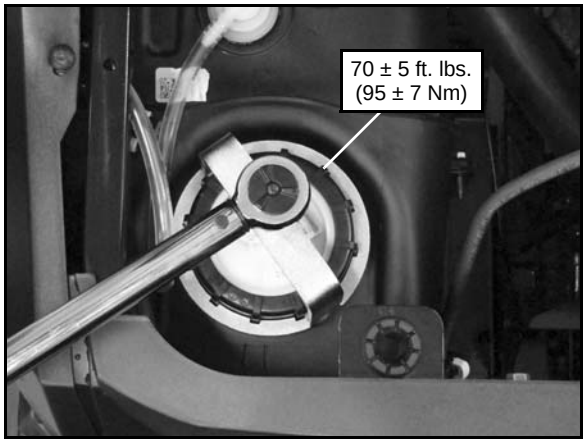
15. Roughly align orientation mark on fuel pump with orientation marks on fuel tank to ensure float arm does not get bent or snagged.



CAUTION
Failure to align the orientation marks may lead to interferences with the fuel level float arm and cause incorrect function.

16. While maintaining downward pressure, thread new PFA nut onto fuel tank and hand tighten. Use care when starting PFA nut, ensuring threads are properly aligned. Verify orientation marks are still aligned between fuel pump and fuel tank.

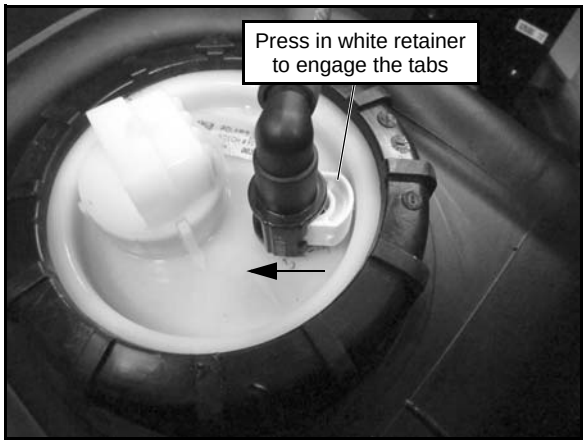
17. Torque PFA nut to specification using the Fuel Pump Service Tool (PU-50326), 3 in. extension and a calibrated torque wrench.



= T
Fuel Pump PFA Nut: **70 ± 5 ft. lbs. (95 ± 7 Nm)**

18. Verify alignment of fuel pump and tank orientation marks.

19. Connect the fuel line to the fuel pump outlet.



IMPORTANT: Be sure to engage the white retainer on fuel line until it snaps into place. Pull on fuel line lightly to confirm connection.

20. Connect the fuel pump electrical harness.

21. Install the lower seat base.

22. Test the fuel pump by turning on the key and listening for the pump to activate. Cycle the key several times to prime the system.

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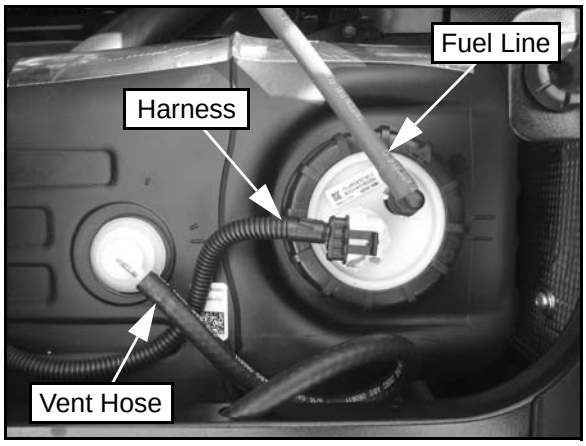
Fuel Tank Removal

WARNING

Always wear safety goggles when working with high pressure or flammable fluids. Failure to do so could result in serious injury or complications.

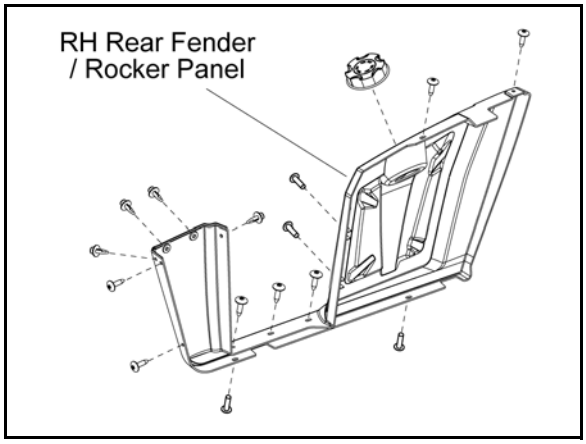
NOTE: Syphon as much fuel from the tank as possible before attempting to remove it from the vehicle.

1. Open hood and disconnect the negative (-) battery cable.
2. Remove the lower seat base.
3. Disconnect the fuel line and electrical harness from the fuel pump.

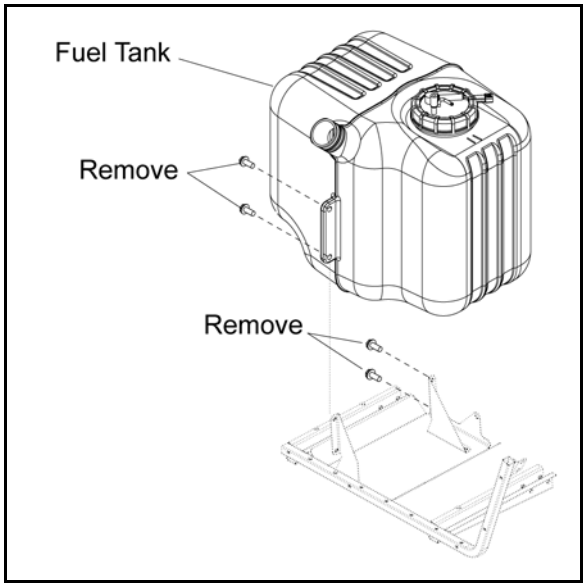


NOTE: A small amount of fuel may come out of the fuel line or tank. Plug the fuel line and tank inlet or use a shop towel during removal.

4. Remove the fuel tank vent hose.
5. Remove the right rear fender/rocker panel assembly and the fuel cap. Reinstall the fuel cap after the fender/rocker panel has been removed.



6. Remove the (4) bolts retaining the fuel tank to the frame support.



7. Remove the (2) screws retaining the rear engine air intake baffle box and allow the box to hang down out of the way.

8. Carefully remove the fuel tank out the RH side of the frame.

NOTE: Properly drain fuel into a suitable container.

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Fuel Tank Installation

1. Reinstall the fuel pump / tank assembly.
2. Reinstall the (4) fuel tank mounting bolts.
3. Reinstall the baffle box and the (2) retaining screws.
4. Reconnect the fuel pump electrical harness.
5. Install the fuel line and vent line, and verify they are secure.
6. Reinstall the right rear fender/rocker panel assembly.
7. Reconnect the negative battery cable. Test the fuel pump by turning on the key and listening for the pump to activate.

FUEL PRESSURE REGULATOR

Operation Overview

The fuel pressure regulator maintains the required operating system pressure of 45 psi ± 2 psi. A rubber-fiber diaphragm divides the regulator into two separate sections: the fuel chamber and the pressure regulating chamber. The pressure regulating spring presses against the valve holder (part of the diaphragm), pressing the valve against the valve seat. The combination of atmospheric pressure and regulating spring tension equals the desired operating pressure. Any time the fuel pressure against the bottom of the diaphragm exceeds the desired (top) pressure, the valve opens, relieving the excess pressure, returning the excess fuel back to the tank.

Fuel Pressure Regulator Test

Refer to the “Fuel Pump Test” procedure.

See “Fuel Pump Test” on page 4.13.

Fuel Pressure Regulator Replacement

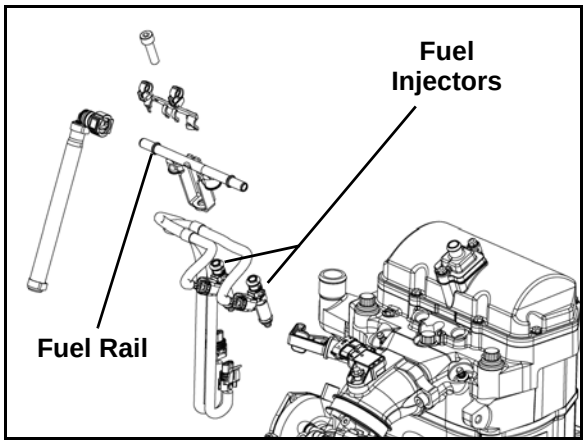
The regulator is a sealed, non-serviceable assembly. If it is faulty, the pump assembly must be replaced. Refer to the Fuel Pump / Tank Assembly Replacement procedure.

FUEL INJECTORS

Operation Overview

NOTE: All EFI units utilize quick connect fuel lines.

The fuel injectors mount into the cylinder head, and the fuel rail attaches to them at the top end. O-rings on both ends of the injector prevent external fuel leaks and also insulate it from heat and vibration.



When the key switch is on, the fuel rail is pressurized, and the EFI relay provides voltage to the injectors. During engine operation, the ECU completes the ground circuit, energizing the injectors. The valve needle in the injector is opened electromagnetically, and the pressure in the fuel rail forces fuel down through the inside. The “director plate” at the tip of the injector contains a series of calibrated openings which directs the fuel into the intake port in a cone-shaped spray pattern.

The amount of fuel injected is controlled by the ECU and determined by the length of time the valve needle is held open, also referred to as the “injection duration” or “pulse width”. It may vary in length depending on the speed and load requirements of the engine.

The ECU gathers fuel injection timing information from the Crankshaft Position Sensor and Camshaft Phase Sensor to allow for sequential fuel injection.

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Fuel Injector Service

Injector problems typically fall into three general categories- electrical, dirty / clogged, or leakage. An electrical problem usually causes one or both of the injectors to stop functioning. Several methods may be used to check if the injectors are operating.

- With the engine running at idle, feel for operational vibration, indicating that they are opening and closing.
- When temperatures prohibit touching, listen for a buzzing or clicking sound with a screwdriver or mechanic's stethoscope.
- Disconnect the electrical connector from an injector and listen for a change in idle performance (only running on one cylinder) or a change in injector noise or vibration.

NOTE: Do not apply voltage directly to the fuel injector(s). Excessive voltage will burn out the injector(s). Do not ground the injector(s) with the ignition on. Injector(s) will open/turn on if relay is energized.

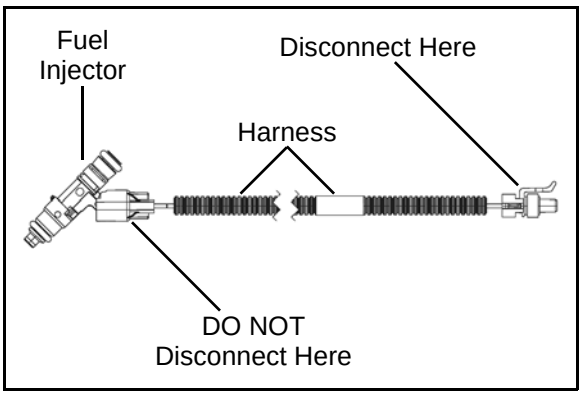
If an injector is not operating, it can indicate either a bad injector, or a wiring/electrical connection problem. Check as follows:

Injector leakage is very unlikely, but in rare instances it can be internal (past the tip of the valve needle), or external (weeping around the injector body). The loss of system pressure from the leakage can cause hot restart problems and longer cranking times.

Injector problems due to dirt or clogging are unlikely due to the design of the injectors, the high fuel pressure, the use of filters and the detergent additives in the gasoline. Symptoms that could be caused by dirty/clogged injectors include rough idle, hesitation/stumble during acceleration, or triggering of fault codes related to fuel delivery. Injector clogging is usually caused by a buildup of deposits on the director plate, restricting the flow of fuel, resulting in a poor spray pattern. Some contributing factors to injector clogging include; dirty air filters, higher than normal operating temperatures, short operating intervals and dirty, incorrect, or poor quality fuel. Cleaning of clogged injectors is not recommended; they should be replaced. Additives and higher grades of fuel can be used as a preventative measure if clogging has been a problem.

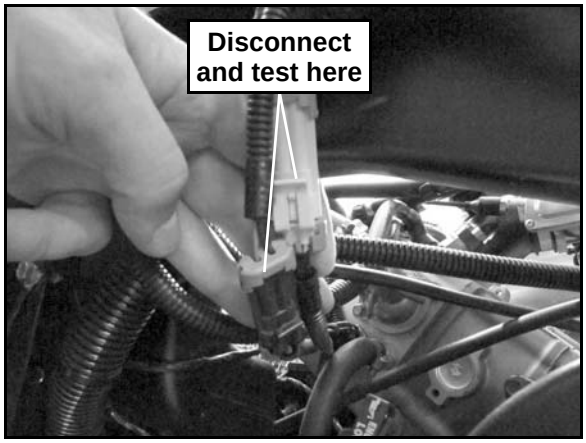
Fuel Injector Test

NOTE: The harness connector and locking spring is bonded to the fuel injectors with an epoxy. DO NOT attempt to disconnect the connector from the fuel injectors. Damage will occur to the injector and/or harness if attempting to separate at that location. Separate the fuel injector from the vehicle harness as shown in the illustration below.



IMPORTANT: Take note of PTO and MAG fuel injector harness connectors before disconnecting them. The harnesses are different and <u>can not</u> be connected incorrectly (PTO - Gray; MAG - Black).

The fuel injectors are non-serviceable. If diagnosis indicates a problem with either injector, test the resistance of the fuel injector(s) by measuring between the two harness pin terminals:



Fuel Injector Resistance Specification:
11.4 Ω - 12.6 Ω

NOTE: Be sure to connect like colored fuel injector connectors for proper engine function (PTO = GRAY, MAG = BLACK).

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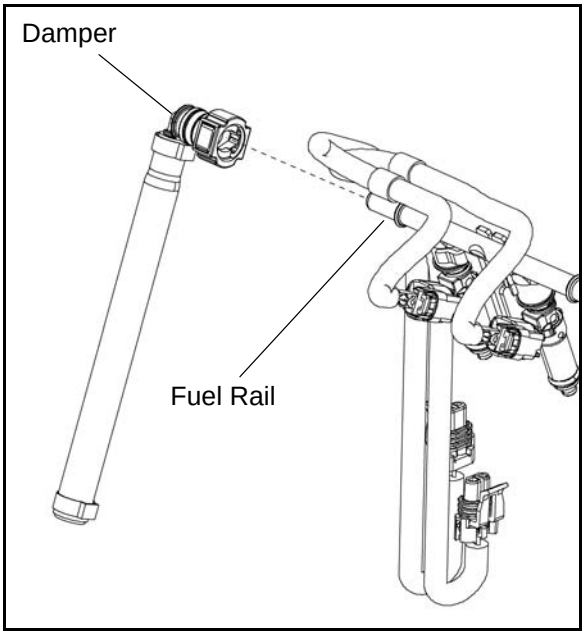
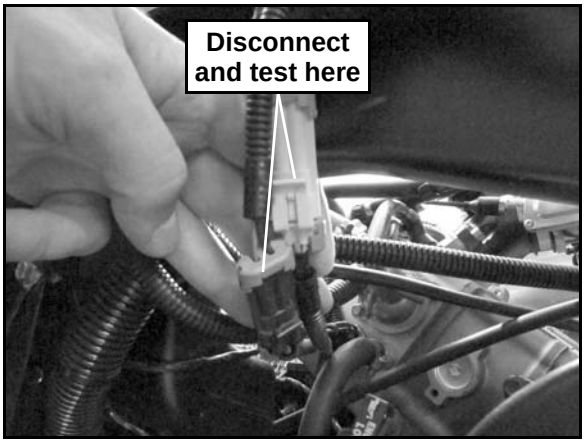
Fuel Injector Replacement

1. Be sure the engine has cooled enough to work on.
2. Thoroughly clean the area around the throttle body, intake boot and fuel injectors.
3. Place a suitable container below the fuel rail damper at the end of the fuel rail. Hold a shop rag over the damper and remove it to depressurize the fuel system.

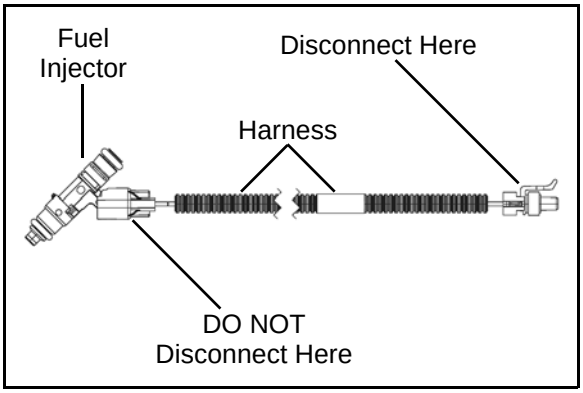


4. Remove the seat base and under-seat storage container to access the fuel injector harnesses.
5. Disconnect the fuel injector harness(s) as shown below.

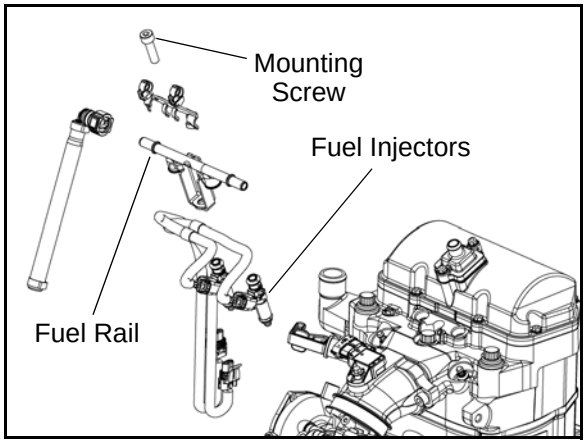


IMPORTANT: Take note of PTO and MAG fuel injector harness connectors before disconnecting them. The harnesses are different and <u>can not</u> be connected incorrectly (PTO - Gray; MAG - Black).

NOTE: The harness connector and locking spring is bonded to the fuel injectors with an epoxy. DO NOT attempt to disconnect the Bosch connector from the fuel injectors. Damage will occur to the injector and/or harness if attempting to separate at that location. Separate the fuel injector from the vehicle harness as shown in the illustration below.



6. Thoroughly clean the area around the fuel injectors including the throttle body manifold.
7. Using a 6 mm hex wrench, loosen the fuel rail mounting screw from the cylinder head. Carefully pull the rail away from the injectors and remove the injector(s) from the cylinder head along with the harness.



8. Reverse the previous steps to install the new injector(s) and reassemble.
9. Lubricate O-rings lightly with oil to aid installation. Torque the fuel rail mounting screw to specification.

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Fuel Rail Mounting Screw: **216 ± 24 in. lbs. (24 Nm)**

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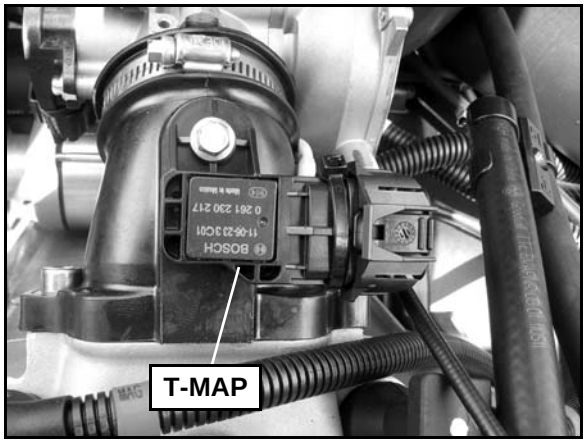
TEMP / MANIFOLD ABSOLUTE PRESSURE SENSOR (T-MAP)

Operation Overview

Mounted on the throttle body intake manifold, the T-MAP sensor performs two functions in one unit.



Air passing through the intake is measured by the T-MAP and relayed to the ECU. These signals, comprised of separate air temperature and manifold absolute pressure readings, are processed by the ECU and compared to its programming for determining the fuel and ignition requirements during operation. The T-MAP sensor provides the ECU with engine load data.

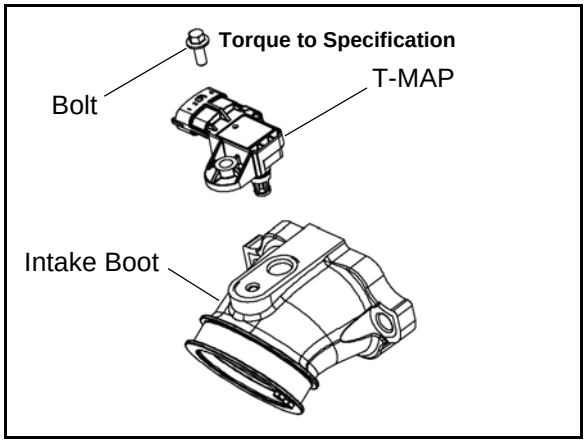
T-MAP Sensor Test

The T-MAP sensor is a non-serviceable item. If it is faulty, it must be replaced.

IMPORTANT: This sensor should only be tested using the Digital Wrench™ Diagnostic Software (dealer only).

T-MAP Sensor Replacement

1. Remove the lower seat base to access the sensor.
2. Remove the cable tie from the sensor connector.
3. Disconnect vehicle harness from T-MAP sensor.
4. Remove the retaining bolt and remove the sensor from the intake boot.
5. Use a light coating of soapy water on the grommet to aid installation of the new sensor.
6. Install the sensor by inserting it with a twisting motion to properly seat the grommet.



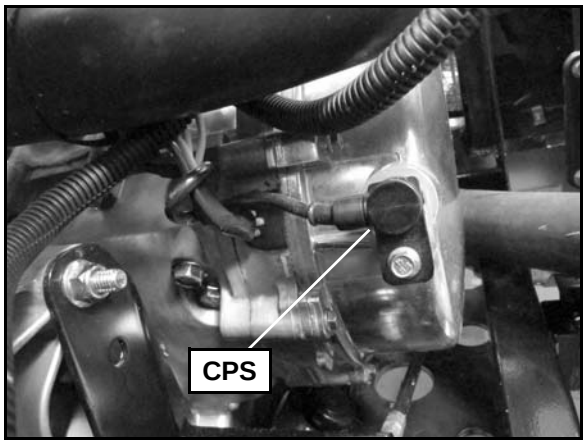
7. Install the retaining bolt and torque to specification.

= T
T-MAP Retaining Bolt: **25 ± 2.5 in. lbs. (3 ± .3 Nm)**

CRANKSHAFT POSITION SENSOR (CPS)

Operation Overview

The crankshaft position sensor is essential to engine operation, constantly monitoring the rotational speed (RPM) and position of the crankshaft.



A ferromagnetic 60-tooth ring gear with two consecutive teeth missing is mounted on the flywheel. The inductive speed sensor is mounted 1.0 ± 0.26 mm (0.059 ± 0.010 in.) away from the ring gear. During rotation, an AC pulse is created within the sensor for each passing tooth. The ECU calculates engine speed from the time interval between the consecutive pulses.

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The two-tooth gap creates an “interrupt” input signal, corresponding to specific crankshaft position. This signal serves as a reference for the control of ignition timing by the ECU. Synchronization of the CPS and crankshaft position takes place during the first two revolutions each time the engine is started. This sensor must be properly connected at all times. If the sensor fails or becomes disconnected for any reason, the engine will stop running.

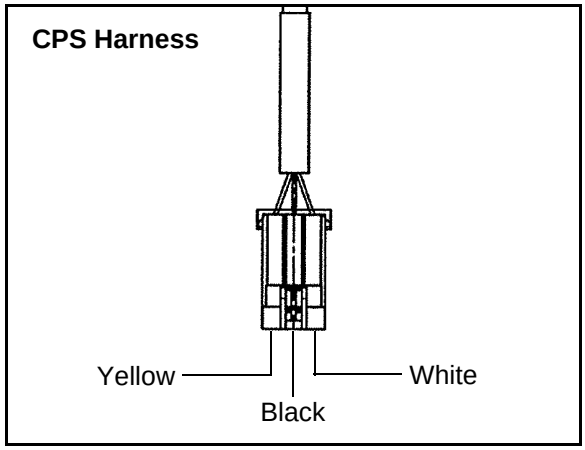
CPS Test

The CPS is a sealed, non-serviceable assembly. If fault code diagnosis indicates a problem with this sensor, test as follows:

1. Disconnect CPS (3-wire) harness connector on the right-hand side of the vehicle located by the air intake hose.

2. Connect an ohmmeter between the pin terminals leading from the Yellow and White wires. A resistance value of **560Ω ± 10%** at room temperature should be obtained.

3. Measure between the pin terminal leading from the Black wire and ground. A resistance value of **0 - 0.5Ω ± 10%** should be obtained.



CPS Resistance Specification:
Yellow to White: 560Ω ± 10%
Black to Ground: 0 - 0.5Ω ± 10%

4. If the resistance is correct.
   - Test the main harness circuit between the sensor connector terminals and the corresponding pin terminals at the ECU (see wiring diagram).
   - Check the sensor mounting, air gap, flywheel ring gear for damage or runout, and flywheel key. Follow the “CPS Replacement” procedure to inspect CPS and flywheel ring gear for damage.

5. If the resistance is incorrect, follow the “CPS Replacement” procedure.

CPS Replacement

1. Disconnect the sensor from the vehicle harness at the connector.

2. Using a 6 mm hex wrench, remove the retaining bolt and replace the sensor.

3. Use a light coating of oil on the O-ring to aid installation.

4. Torque the retaining bolt to specification.

= T
CPS Retaining Bolt: **25 in. lbs. (2.8 Nm)**

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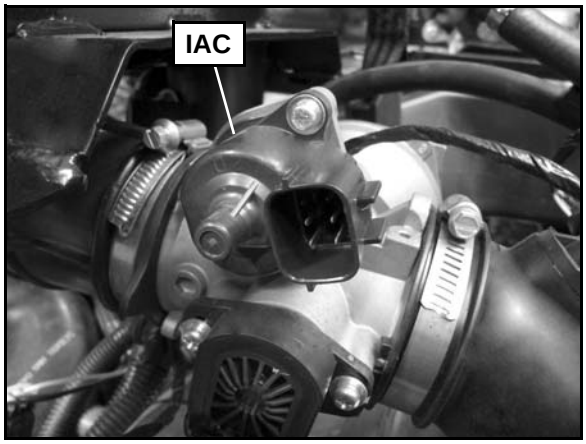
IDLE AIR CONTROL (IAC)

Operation Overview

The Idle Air Control (IAC) is used to stabilize the idle quality of the engine at cold start-up and after warm-up operations.



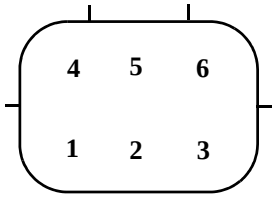
Mounted on the throttle body, the IAC contains 1 stepper motor which receives varying voltage signal pulses from the ECU. These pulses determine the IAC plunger setting, thereby controlling the amount of air bypassing the closed throttle body for idle control. If the IAC is disconnected or inoperative, it will remain at it's last operated position.

IAC Test

The IAC is a non-serviceable item. If it is faulty, it must be replaced. It can be 'bench tested' using the following method:

Set your meter to read Ohms. Check the resistance values at each of the following pin locations of the IAC. If any of the readings are out of specification, replace the IAC.

IAC Valve Connector

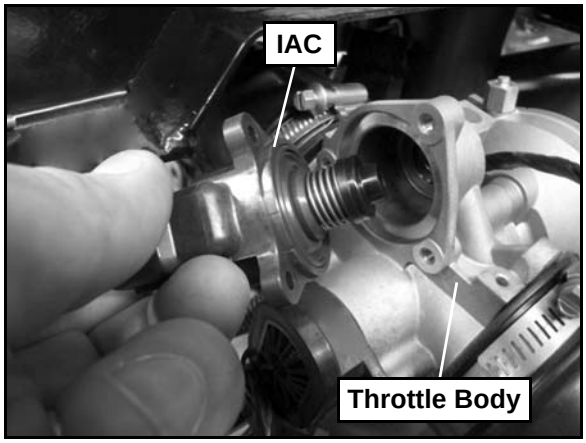


IAC Resistance Readings

Pins	Resistance	Pins	Resistance
1 - 2	30 Ω ± 1.2 Ω	4 - 5	30 Ω ± 1.2 Ω
2 - 3	30 Ω ± 1.2 Ω	5 - 6	30 Ω ± 1.2 Ω
1 - 3	60 Ω ± 2.4 Ω	4 - 6	60 Ω ± 2.4 Ω

IAC Replacement

1. Remove the lower seat base.
2. Disconnect the vehicle harness from the IAC motor.
3. Remove the (3) Phillips-head mounting screws and remove the IAC from the throttle body.



4. Install the new IAC and torque the mounting screws to specification.

= T
IAC Mounting Screw: **17.7 in. lbs. (2 ± 0.5 Nm)**

5. Reconnect the vehicle harness to the IAC motor.
6. Reinstall the lower seat base.

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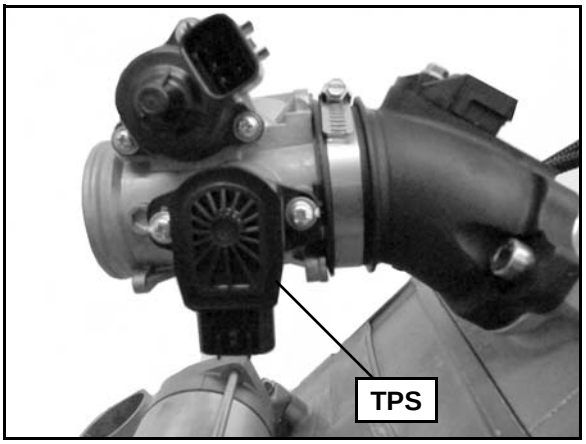
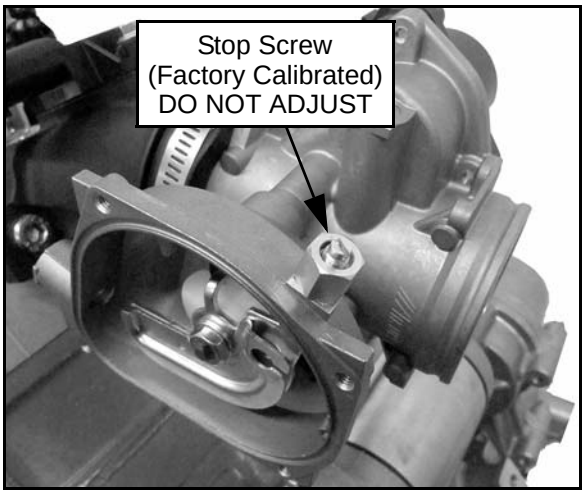
THROTTLE POSITION SENSOR (TPS)

Operation Overview

The throttle position sensor (TPS) is used to indicate throttle plate angle to the ECU. Mounted on the throttle body and operated directly off the end of the throttle shaft, the TPS works like a rheostat, varying the voltage signal to the ECU in direct correlation to the angle of the throttle plate. This signal is processed by the ECU and compared to the internal pre-programmed “maps” to determine the required fuel and ignition settings for the amount of engine load.



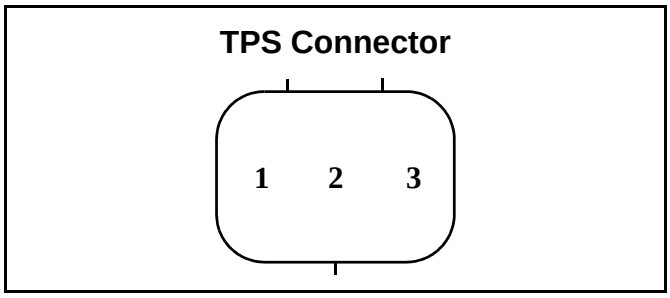


The correct position of the throttle body stop screw is established and set at the factory. DO NOT loosen the throttle body stop screw or alter its position in any manner. The stop screw controls the air flow calibration of the throttle body. If the stop screw is repositioned or adjusted, the throttle body assembly must be replaced.

TPS Resistance Tests

The TPS is a non-serviceable item. If it is faulty, it must be replaced. It can be tested using the following method:

With the test leads connected and the meter set to the ohms scale, observe the reading at the following pin locations of the TPS:



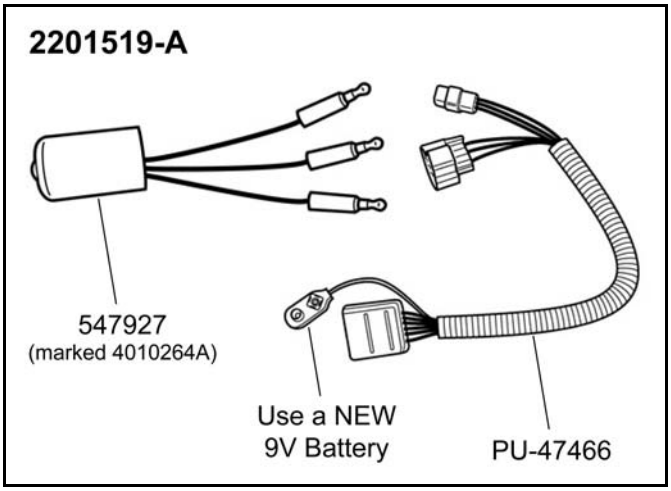
TPS Resistance Readings

Pins	Throttle Position	Resistance
2 - GND	-----	∞
1 - 2	Closed	4kΩ - 5kΩ (reference)
1 - 2	Open	1150Ω - 1250Ω
1 - 3	-----	4kΩ – 6kΩ

TPS Tester / Regulator

The TPS reading can be checked by using the Throttle Position Sensor (TPS) Tester (2201519-A).

Set-up the TPS Tester Wire Harness (PU-47466) and TPS Tester Regulator (547927) according to the instructions that accompanied the tester. Make sure the 9 Volt battery is new.



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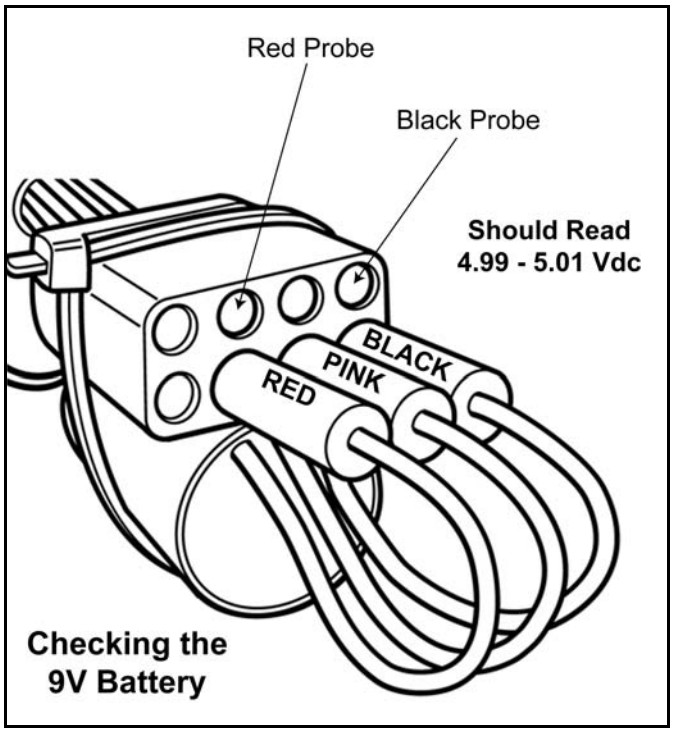
Verify TPS Tester Reference Voltage

A 5 volt reference voltage from the TPS Tester harness is required for the TPS test to be accurate. Refer to the instructions provided with the TPS Tester **(2201519-A)** or follow the bullet point steps below to check reference voltage.

Reference Voltage Test:

- Insert black voltmeter probe into the test port as shown.
- Insert red voltmeter probe into the test port as shown and verify the voltage reads 4.99-5.01 Vdc. If the reading is low, replace the 9 volt battery.



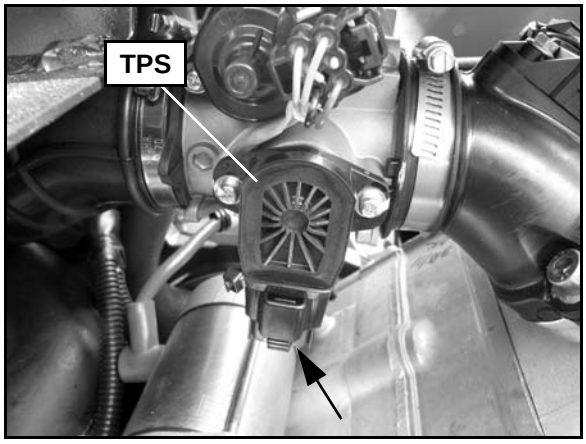
TPS Reference Voltage
5 Vdc Input

IMPORTANT: Always use a fresh 9 Volt battery.

TPS Replacement

NOTE: The correct position of the TPS angle on the throttle body is established and set at the factory. If the TPS is replaced or has been loosened it must be repositioned to obtain the proper voltage reading.

1. Remove the lower seat base.
2. Loosen the two hose clamps that secure the intake boots to the throttle body.
3. Disconnect the vehicle harness from the TPS.



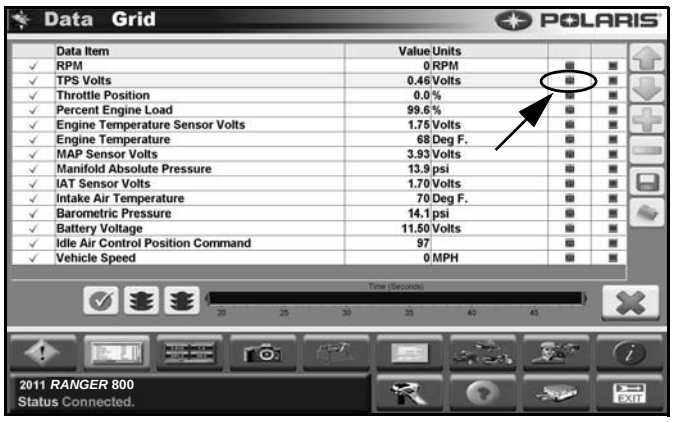
4. Rotate the throttle body to gain access to the TPS mounting screws.
5. Remove the (2) Phillips-head mounting screws and replace the TPS. Reconnect the vehicle harness to the TPS.

NOTE: If replacing the TPS or throttle body, you must set the TPS voltage to specification.

IMPORTANT: The TPS voltage reading using the TPS Tester tool will differ from the reading you get using the Digital Wrench™ data display. Refer to the following procedures.

TPS Adjustment Using Digital Wrench™:

1. Assemble SmartLink Module and connect the diagnostic interface cable to the vehicle to allow Digital Wrench™ use (see “Digital Wrench™ - Diagnostic Connector”).
2. Select the appropriate vehicle and open the data display grid. Click on the meter icon next to “TPS Volts”.



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3. Loosen the TPS mounting screws (see Figure 4-31).

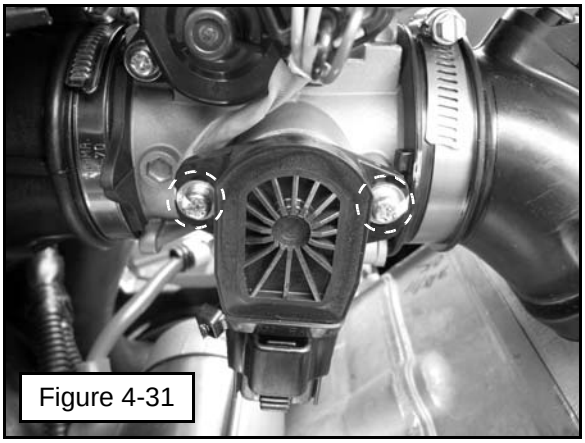
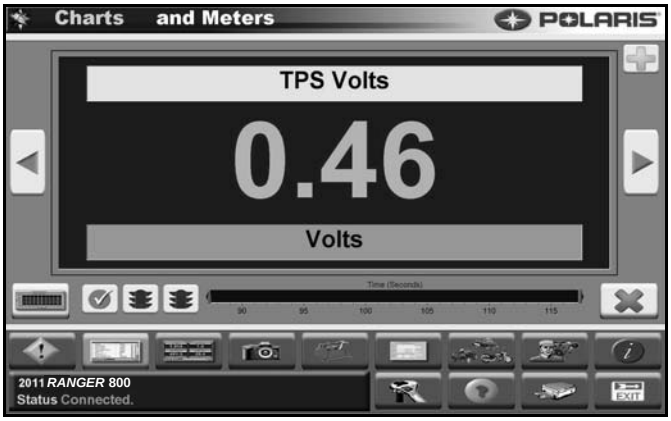


Figure 4-31

4. Rotate the TPS until your display reading is within specification.



TPS Output Reading (Digital Wrench™):
0.46 ± 0.03 Vdc

5. Retighten the TPS mounting screws and torque to specification.

= T
TPS Mounting Screws: **17.7 in. lbs. (2 Nm)**

6. Verify voltage reading did not change. If voltage reading is now out of specification, repeat steps 3 - 5.
7. Reposition the throttle body and securely tighten the hose clamps.
8. Reinstall the lower seat base.

TPS Adjustment Using TPS Tester (PN 2201519-A):

1. If Digital Wrench™ is unavailable, assemble the TPS Tester according to the instructions. Refer to "TPS Tester / Regulator" for proper set-up and testing. Verify the 9 volt tester battery is new.
2. Plug the TPS Tester harness into the new TPS.
3. Set your voltmeter to read DC Volts. Insert the red and black voltmeter probes into the test ports as shown.

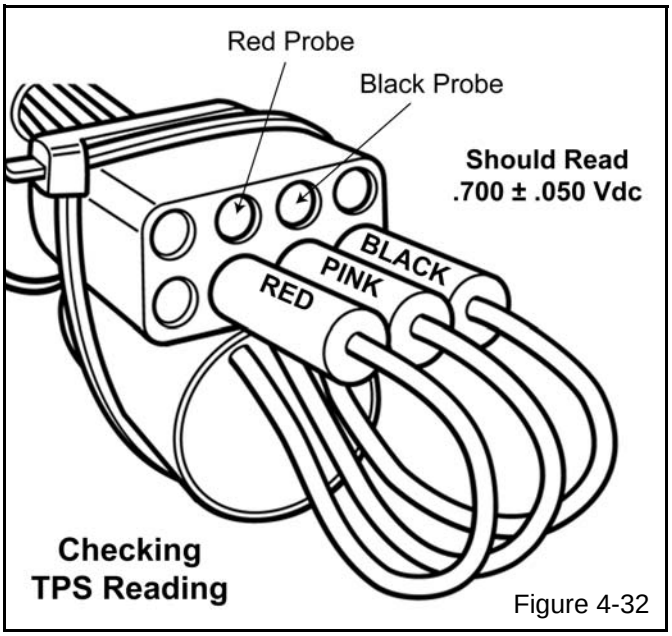


Figure 4-32

4. Loosen the TPS mounting screws (see Figure 4-31).
5. Rotate the TPS until your voltmeter reads within the specification (see Figure 4-32).

TPS Output Reading (TPS Tester):
.700 ± .050 Vdc

6. Retighten the TPS mounting screws and torque to specification.

= T
TPS Mounting Screws: **17.7 in. lbs. (2 Nm)**

7. Verify voltage reading did not change. If voltage reading is now out of specification, repeat steps 4 - 6.
8. Reconnect the vehicle harness to the TPS.
9. Reposition the throttle body and securely tighten the hose clamps.
10. Reinstall the lower seat base.

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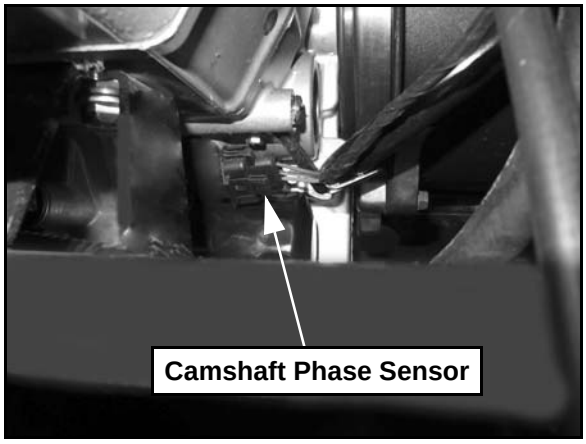
CAMSHAFT PHASE SENSOR

Operation Overview

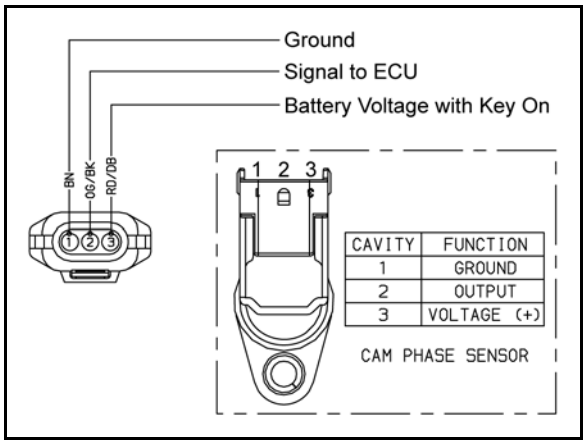
Mounted on the engine crankcase near the oil filter, the Cam Phase Sensor provides camshaft position information to the ECU to be used along with the crankshaft position data to allow for sequential fuel injection.



Cam Phase Sensor Test

The Cam Phase Sensor is a non-serviceable item. If it is faulty, it must be replaced.

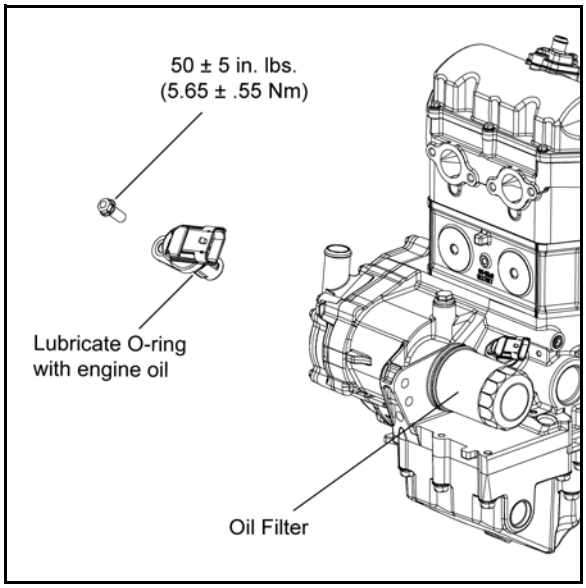
With the ignition key switch on, the sensor should have battery voltage present on the Red / Dark Blue wire and ground present on the Brown wire.



NOTE: Use Digital Wrench™ Diagnostic Software (dealer only) if you suspect this sensor is faulty.

Cam Phase Sensor Replacement

1. Remove the seat base and under-seat storage container.
2. Disconnect vehicle harness from the sensor.
3. Remove the retaining bolt and remove the sensor from the engine.
4. Use a light coating of engine oil to lubricate the O-ring upon installation of the new sensor.
5. Install the sensor by inserting it with a twisting motion to allow it to properly seat.



6. Install the retaining bolt and torque to specification.

= T
Cam Phase Sensor Retaining Bolt: **50 ± 5 in. lbs. (5.65 ± .55 Nm)**

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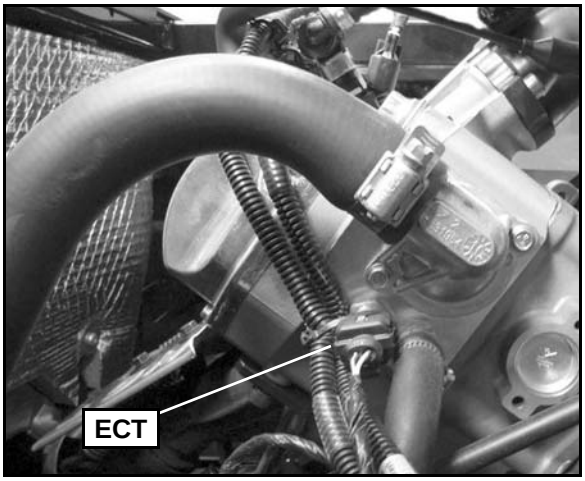
ENGINE COOLANT TEMPERATURE SENSOR (ECT)

Operation Overview

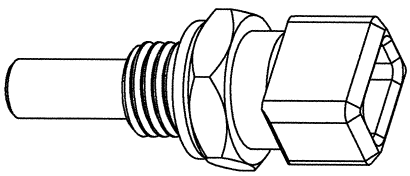
Mounted on the cylinder head, the engine temperature sensor measures coolant temperature. The engine temperature sensor is a Negative Temperature Coefficient (NTC) type sensor, as the temperature increases the resistance decreases.



Coolant passes through the cylinder and by the sensor probe, varying a resistance reading which is relayed to the ECU. This signal is processed by the ECU and compared to its programming for determining the fuel and ignition requirements during operation. The ECU also uses this signal to determine when to activate the fan during operation.

ECT Sensor Test

To quickly rule out other components and wiring related to the ECT, disconnect the harness from the ECT sensor and start the engine. After a few seconds, the fan should turn on and the “Check Engine” indicator should display on the instrument cluster. This indicates all other components are working properly.



ECT Sensor

Refer to Chapter 10 for additional ECT sensor information. Polaris dealers can test the sensor by using the Digital Wrench™ Diagnostic Software (dealer only).

ECT Sensor Resistance Readings

Temperature °F (°C)	Resistance
68 °F (20 °C)	2.5k Ω ± 6%
86 °F (30 °C)	1.7k Ω ± 6%
104 °F (40 °C)	1.2k Ω ± 6%
122 °F (50 °C)	834 Ω ± 6%
140 °F (60 °C)	596 Ω ± 6%
158 °F (70 °C)	435 Ω ± 6%
176 °F (80 °C)	323 Ω ± 6%
194 °F (90 °C)	243 Ω ± 6%
212 °F (100 °C)	186 Ω ± 6%

ECT Sensor Replacement

1. Remove the seat base and under-seat storage container to access the ECT sensor.
2. Drain coolant to level below sensor.
3. Disconnect sensor from engine harness.
4. Using a wrench, remove and replace the sensor, applying a light coating of thread sealant to aid installation.
5. Torque the sensor to specification.

= T
ECT Sensor: **17 ft. lbs. (23 Nm)**

6. Add the required amount of coolant and properly bleed the cooling system (see Chapter 3).

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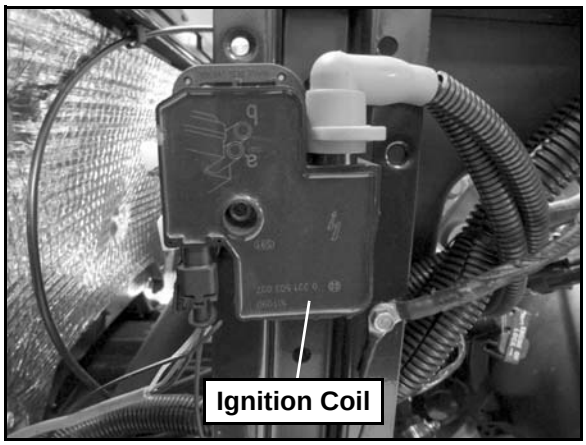
IGNITION COIL

Operation Overview

The ignition coil is used to provide high voltage to fire the spark plugs. When the ignition key is on, DC voltage is present in the primary side of the ignition coil windings. During engine rotation, an AC pulse is created within the crankshaft position sensor for each passing tooth on the flywheel. The two-tooth gap creates an “interrupt” input signal, corresponding to specific crankshaft position. This signal serves as a reference for the control of ignition timing. The ECU then calculates the time interval between the consecutive pulses, and determines when to trigger the voltage spike that induces the voltage from the primary to the secondary coil windings to fire the spark plugs.



Ignition Coil / HT Lead Replacement

NOTE: Mark or note which ignition coil wire goes to which cylinder and ignition coil post. The engine will misfire if spark plug wires are installed incorrectly. The spark plug wires are marked with PTO and MAG from the factory and should be installed to the corresponding cylinder and ignition coil post.

1. Remove the seat base and under-seat storage container.
2. Disconnect the ignition coil harness and remove the high tension leads from the coil.
3. Remove the fastener retaining the ignition coil and remove it from the vehicle. If replacing the high tension lead(s), remove the other end of the lead(s) from the spark plug.
4. Install the new ignition coil and/or high tension lead(s).

= T
Ignition Coil Retaining Bolt: **75 in. lbs. (8.5 Nm)**

Ignition Coil Tests

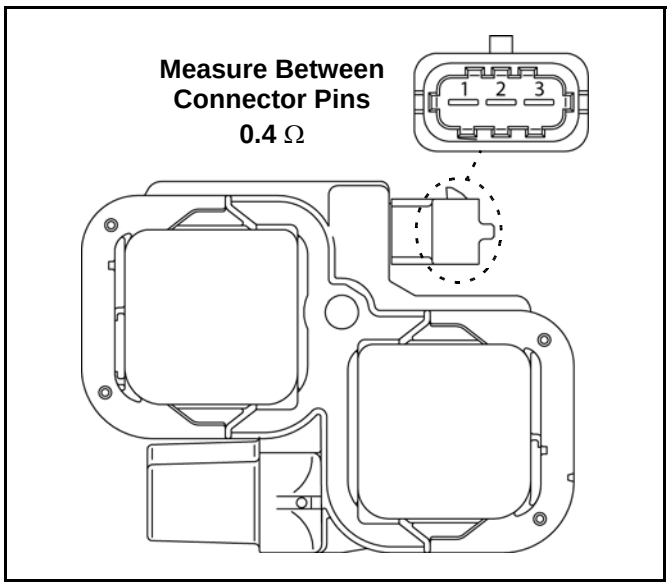
The ignition coil can be tested by using an ohm meter. Use the following illustration and specification table to test the ignition coil resistance.

NOTE: The under-seat storage container must be removed to properly access the ignition coil harness for testing purposes.

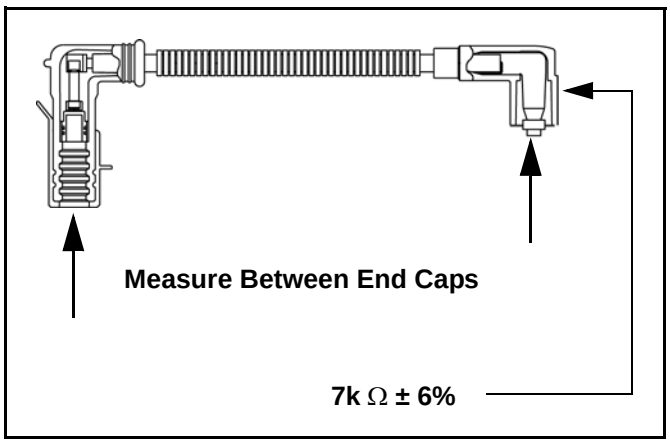
Ignition Coil Resistance Readings

Test	Pin Connection	Resistance
Primary	Between 1 & 2 Between 2 & 3	0.4 Ω
Secondary	Between High Tension Lead End Caps	7k Ω ± 6%

Primary Test



Secondary Test



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EFI DIAGNOSTICS

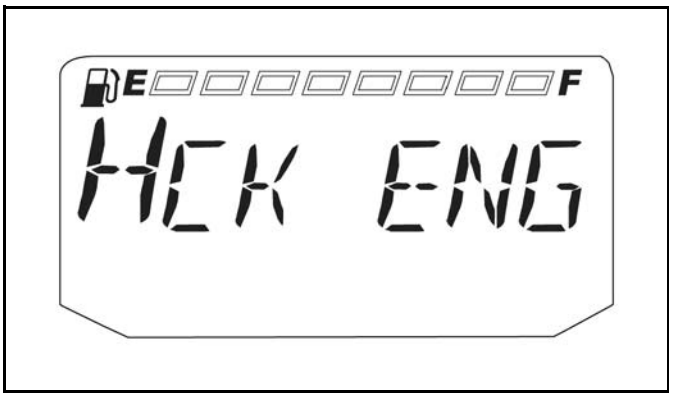
Instrument Cluster Trouble Code Display

NOTE: The diagnostic mode is accessible only when the check engine MIL has been activated.

Use the following procedure to display diagnostic trouble codes that were activated during current ignition cycle causing the MIL to illuminate. Diagnostic trouble codes will remain stored in the gauge (even if MIL turns off) until the key is turned off.

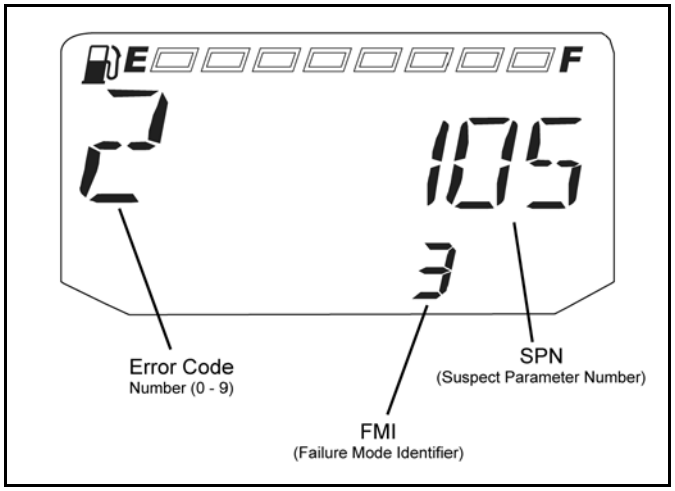
NOTE: If there is a diagnostic problem with the power steering system, the power steering MIL will illuminate and blink in place of the check engine MIL.

1. If the trouble code(s) are not displayed, use the MODE button to toggle until “CK ENG” displays on the information display area.



2. Press and hold the MODE button to enter the diagnostics code menu.

3. A set of three numbers will appear in the information area.
   - The first number (located far left) can range from 0 to 9. This number represents the total number of trouble code present (example: 2 means there are 3 codes present).
   - The second number (located top right) can be 2 to 6 digits in length. This number equates to the suspected area of fault (SPN).
   - The third number (located bottom right) can be 1 to 2 digits in length. This number equates to the fault mode (FMI).



4. If more than one code exists, press the MODE button to advance to the next trouble code.

5. To exit the diagnostic mode, press and hold the MODE button or turn the ignition key OFF once the codes are recorded.

DIAGNOSTIC TROUBLE CODE TABLE

Component	Condition	SPN	FMI	Digital Wrench™ P-Code
Throttle Position Sensor (TPS)	Voltage Too High	51	3	P0123
	Voltage Too Low		4	P0122
Vehicle Speed Signal	Data Erratic or Intermittent (or missing)	84	2	P0503
	Received Vehicle Speed Has Error		19	C1069
Manifold Absolute Pressure Sensor (T-MAP)	Voltage Too High	102	3	P0108
	Voltage Too Low		4	P0107
Intake Air Temperature (T-MAP)	Voltage Too High	105	3	P0113
	Voltage Too Low		4	P0112

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DIAGNOSTIC TROUBLE CODE TABLE

Component	Condition	SPN	FMI	Digital Wrench™ P-Code
Engine Temperature Sensor (ECT)	Voltage Too High	110	3	P0118
	Voltage Too Low		4	P0117
	Temperature Too High		16	P0217
	Engine Overheat Shutdown		0	P1217
System Power (Battery Potential / Power Input)	Voltage Too High	168	3	P0563
				C1063
	Voltage Too Low		4	P0562
				C1064
Engine Speed (This is applicable when the EPS module gets the engine speed from the ECM)	Engine Speed Too High	190	0	C1059
	Received Engine Speed Has Error		19	C1066
Gear Sensor Signal	Voltage Too Low	523	4	P0916
ECU Memory	EEPROM: Read/Write Failure	628	12	C1073
Calibration	Checksum/CRC Error	630	13	C1074
Crankshaft Position Sensor (CPS)	Plausibility Fault	636	2	P0335
Camshaft Phase Sensor	Circuit Fault	637	8	P0340
Injector 1 (MAG)	Driver Circuit Open / Grounded	651	5	P0261
	Driver Circuit Short to B+		3	P0262
	Driver Circuit Grounded		4	P1262
Injector 2 (PTO)	Driver Circuit Open / Grounded	652	5	P0264
	Driver Circuit Short to B+		3	P0265
	Driver Circuit Grounded		4	P1265
Rear Differential Output	Driver Circuit Open / Grounded	746	5	P1691
	Driver Circuit Short to B+		3	P1692
	Driver Circuit Grounded		4	P1693
Fan Relay Driver Circuit	Driver Circuit Open / Grounded	1071	5	P1481
	Driver Circuit Short to B+		3	P1482
	Driver Circuit Grounded		4	P1483
Ignition Coil Primary Driver 1 (MAG)	Driver Circuit Short to B+	1268	3	P1353
Ignition Coil Primary Driver 2 (PTO)	Driver Circuit Short to B+	1269	3	P1354
Fuel Pump Driver Circuit	Driver Circuit Open / Grounded	1347	5	P0230
	Driver Circuit Short to B+		3	P0232
	Driver Circuit Grounded		4	P0231
ECU Output Supply Voltage 1	Voltage Too High	3597	3	P16A2
	Voltage Too Low		4	P16A1

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DIAGNOSTIC TROUBLE CODE TABLE

Component	Condition	SPN	FMI	Digital Wrench™ P-Code
ECU Output Supply Voltage 2	Voltage Too High	3598	3	P16A9
	Voltage Too Low		4	P16A8
All Wheel Drive Control Circuit (AWD)	Driver Circuit Open / Grounded	520207	5	P1836
	Driver Circuit Short to B+		3	P1835
	Driver Circuit Grounded		4	P1834
Steering Over Current Shut Down	Current Above Normal or Grounded	520221	6	C1050
Steering Excessive Current Error	Current Above Normal or Grounded	520222	6	C1051
Steering Torque Partial Failure	Condition Exists	520223	31	C1052
Steering Torque Full Failure	Condition Exists	520224	31	C1053
EPS Inverter Temperature	Greater than 110° C (230° F)	520225	16	C1054
	Greater than 120° C (248° F)		0	C1055
EPS CAN Communications Receive Error	No RX Message for 2 Seconds	520226	2	U0100
EPS CAN Communications Transmit Error	No TX Message for 2 Seconds	520227	2	U1100
Position Encoder Error	Position Encoder Error	520228	11	C1065
EPS Software Error	Software Error	520229	12	C1070
IC CAN Communication with EPS	EPS Off Line (EPS DM1 not seen)	520230	31	U0131
Idle Air Control Valve (IAC) M17; IAC Stepper Pin 1 **MODEL YEAR 2011**	Driver Circuit Open / Grounded	520267	5	P1505
	Driver Circuit Short to B+		3	P1509
	Driver Circuit Grounded		4	P1508
Idle Air Control Valve (IAC) M17; IAC Stepper Pin 3	Driver Circuit Open / Grounded	520268	5	P1515
	Driver Circuit Short to B+		3	P1519
	Driver Circuit Grounded		4	P1518
Idle Air Control Valve (IAC) M17; IAC Stepper Pin 4	Driver Circuit Open / Grounded	520269	5	P1525
	Driver Circuit Short to B+		3	P1529
	Driver Circuit Grounded		4	P1528
Idle Air Control Valve (IAC) M17; IAC Stepper Pin 6	Driver Circuit Open / Grounded	520270	5	P1535
	Driver Circuit Short to B+		3	P1539
	Driver Circuit Grounded		4	P1538
Idle Air Control Valve (IAC) M17; IAC Stepper Pin 1 **MODEL YEAR 2012**	Driver Circuit Open / Grounded	520271	5	P1505
	Driver Circuit Short to B+		3	P1509
	Driver Circuit Grounded		4	P1508

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EFI Troubleshooting

Fuel Starvation / Lean Mixture

Symptoms: Hard start or no start, bog, backfire, popping through intake / exhaust, hesitation, detonation, low power, spark plug erosion, engine runs hot, surging, high idle, idle speed erratic.

- No fuel in tank
- Restricted tank vent, or routed improperly
- Fuel lines or fuel injectors restricted
- Fuel filter plugged
- Fuel pump inoperative
- Air leak in system
- Intake air leak (throttle shaft, intake ducts, airbox or air cleaner cover)
- Incorrect throttle stop screw adjustment

Rich Mixture

Symptoms: Fouls spark plugs, black, sooty exhaust smoke, rough idle, poor fuel economy, engine runs rough/misses, poor performance, bog, engine loads up, backfire.

- Air intake restricted (inspect intake duct)
- Air filter dirty/plugged
- Poor fuel quality (old fuel)
- Fouled spark plug
- TPS setting incorrect
- Injector failure

Poor Idle

Symptom: Idle Too High (If greater than 1300 RPM when engine is warm).

- Throttle stop screw set incorrect
- Throttle cable sticking, improperly adjusted, routed incorrectly
- Faulty electrical connection

Symptom: Idle Too Low (if less than 900 RPM when engine is warm).

- Plugged air filter
- Leaking injector (rich condition)
- Belt dragging
- Throttle stop screw tampering

Symptom: Erratic Idle.

- Throttle cable incorrectly adjusted
- Air Leaks, dirty injector
- TPS damaged or adjusted
- Tight valves
- Ignition timing incorrect
- Belt dragging
- Dirty air cleaner
- Engine worn
- Spark Plug fouled
- Throttle stop screw set incorrectly (out of sync with ECU)
- Faulty electrical connection

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DIGITAL WRENCH™ OPERATION

Digital Wrench™ Diagnostic Software Overview

IMPORTANT: Refer to Section 2, 3 and 4 in the Instruction Manual provided in the Digital Wrench™ Diagnostic Kit to install the Polaris Digital Wrench™ diagnostic software on your computer.

The Digital Wrench™ diagnostic software allows the technician to perform the following tests and observations:

- View or clear trouble codes
- Analyze real-time engine data
- Reflash ECU calibration files
- Perform guided diagnostic procedures
- Create customer service account records
- Perform output state control tests (some models)

Special Tools (also refer to page 4.2)

DIGITAL WRENCH™ DIAGNOSTIC SOFTWARE	PART NUMBER
Digital Wrench™ Diagnostic Kit	PU-47063-B
PU-47063-B (listed above) INCLUDES:	Digital Wrench™ Software: PU-48731
	Standard Interface Cable: PU-47151
	SmartLink Module Kit: PU-47471
	USB-Serial Adapter Cable: PU-50621
Fuel Pressure Gauge Kit	PU-43506-A
Fuel Pressure Gauge Adapter	PV-48656
Fluke 73 Digital Multi-Meter or Fluke 77 DMM	PV-43546 (Fluke 77: PV-43568)
Laptop or Desktop Computer	Commercially Available (refer to diagnostic software user manual or HELP section for minimum requirements)

Diagnostic Software Version

Always use the most current version of the Digital Wrench™ software to ensure you have the latest updates or enhancements. New reprogramming files and guided diagnostic procedures are added to these updates as they become available. For information on how to determine if you have the latest update available, refer to “Digital Wrench™ Version and Update ID”.

ECU Replacement

Although the need for ECU replacement is unlikely, a specific replacement procedure is required to ensure that all essential data contained within the original ECU is transferred to the replacement ECU.

Refer to procedure and carefully follow all instructions provided in Digital Wrench™.

Guided Diagnostic Available

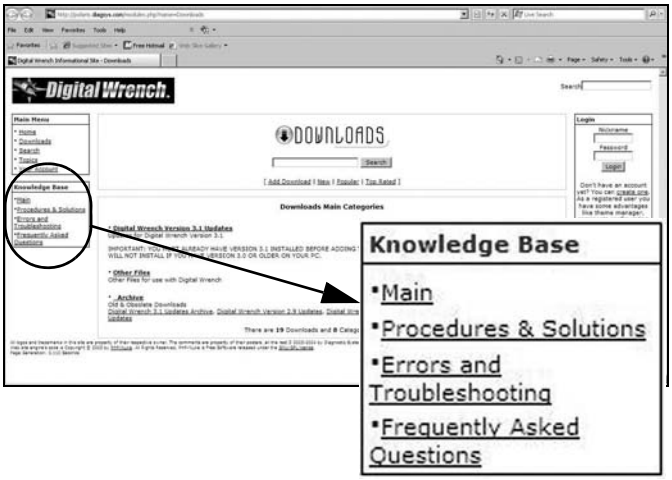
Guided diagnostics are available within Digital Wrench™ for all supported Trouble Codes (that is, any fault that will turn on the ‘Check Engine’ indicator).

In addition, guided diagnostics are also available for many other electrical sub systems.

Diagnostic procedures are added to subsequent versions of Digital Wrench™ as they become available. Check your release version often and upgrade when available to be sure you are using the most current software available.

Digital Wrench™ Communication Errors

If you experience problems connecting to a vehicle or any Digital Wrench™ related problem, visit the Digital Wrench™ Knowledge Base for the most current troubleshooting information, FAQs, downloads and software updates at: ***http://polaris.diagsys.com/.***



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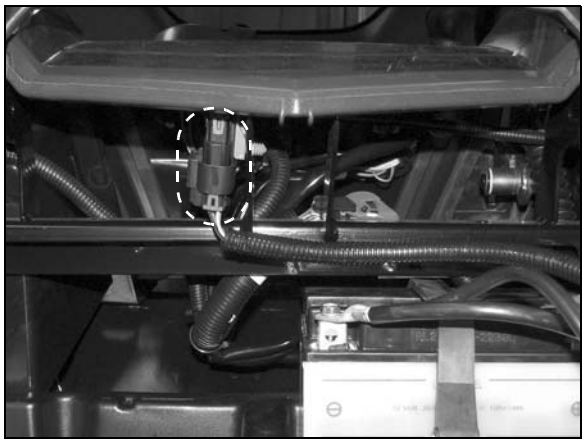
Digital Wrench™ - Diagnostic Connector

The diagnostic connector is located under the hood as shown below.

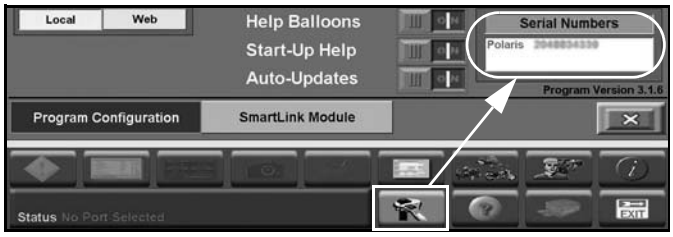


Follow these steps to connect the diagnostic interface cable to the vehicle to allow Digital Wrench™ use:

1. Assemble the SmartLink Module and attach the PC Interface Cable to your laptop (see page 4.3).
2. Remove the protective cap from the Digital Wrench™ connector.
3. Connect the Vehicle Interface Cable to the Digital Wrench™ diagnostic connector.
4. Turn the ignition key to the 'ON' position, select the appropriate vehicle and wait for the status to display 'Connected' in the lower left corner of the screen.
5. Once connected, proceed with using Digital Wrench™.

Digital Wrench™ Serial Number Location

Open the configuration screen by clicking on the wrench icon. The serial number is located on the right side of the screen.

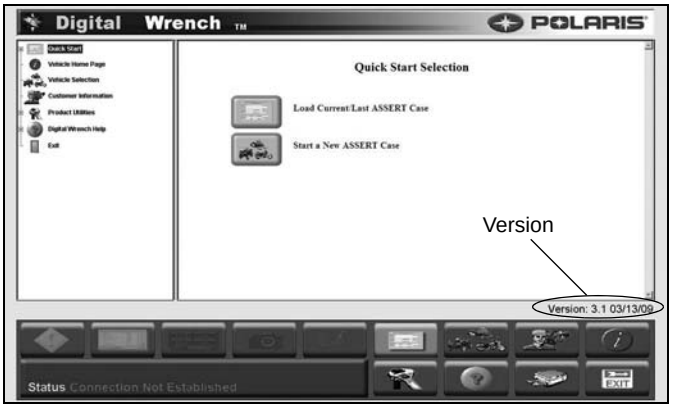


Digital Wrench™ Version and Update ID

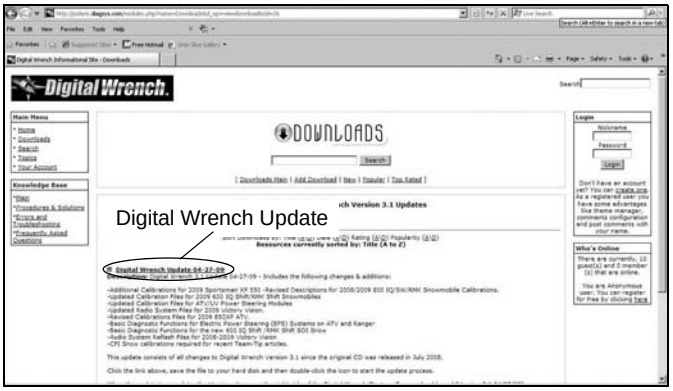
Knowing what Digital Wrench™ version and update is installed will help determine which updates are required.

NOTE: Versions and updates are subject to change.

1. Open the Digital Wrench™ software. Locate the version ID shown on the lower right side of the Digital Wrench™ start-up screen.



2. Proceed to ***http://polaris.diagsys.com*** to see if a newer update is available.



3. If a newer update is available, it should be downloaded before using Digital Wrench™ (see "Digital Wrench™ Updates").

IMPORTANT: Always operate with the latest update.

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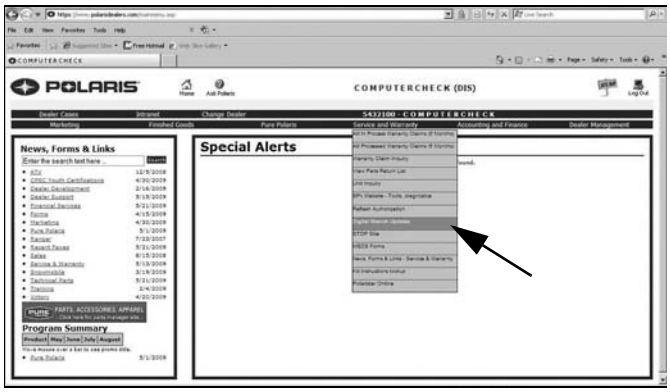
Digital Wrench™ Updates

Updates are released for Digital Wrench™ via the Internet at: ***http://polaris.diagsys.com***. The Digital Wrench™ website can also be accessed through the dealer website at: ***www.polarisdealers.com***.

NOTE: Only authorized Polaris dealers and distributors can access the dealer website.

1. Log on to ***www.polarisdealers.com***.
2. Locate the "**Service and Warranty**" drop-down menu.
3. Click on "**Digital Wrench Updates**".



4. The Digital Wrench™ portal website should appear in a new web browser.
5. Click on "**Digital Wrench Version Updates**".

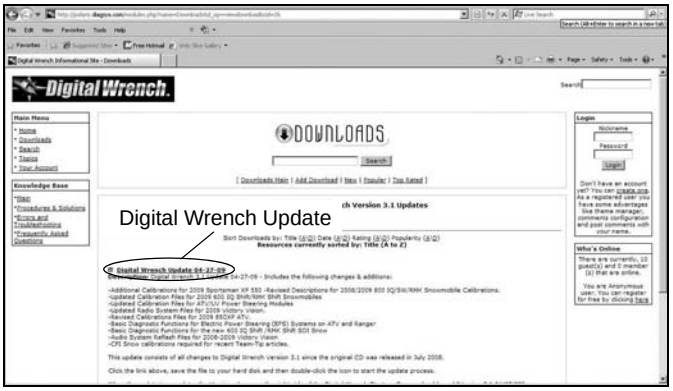
IMPORTANT: You must already have the current version installed before adding an update. Updates will not install if you are using an older version loaded on your PC.

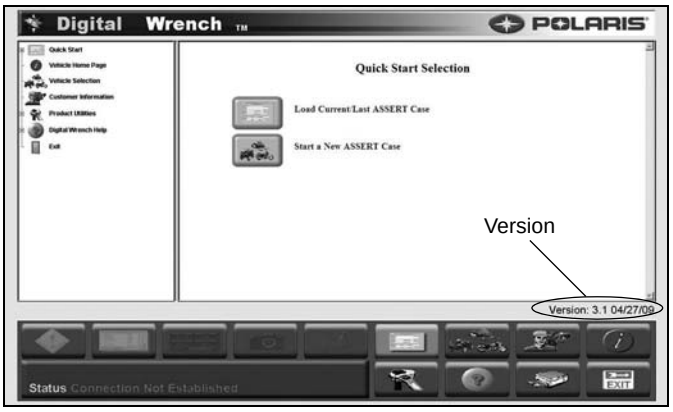
6. If the update file date listed is newer than your current version and update (see "Digital Wrench™ Version and Update ID"), download the file.

7. Click on the link shown above, save the file to your hard disk and then double-click the icon to start the update process.

NOTE: Do not "run" or "open" the file from where they are. Select "save" and download them to your PC before running the install.

8. When the update is complete, the version shown on the right side of the Digital Wrench™ start-up screen should match the update you just downloaded.





NOTE: Versions and updates are subject to change.

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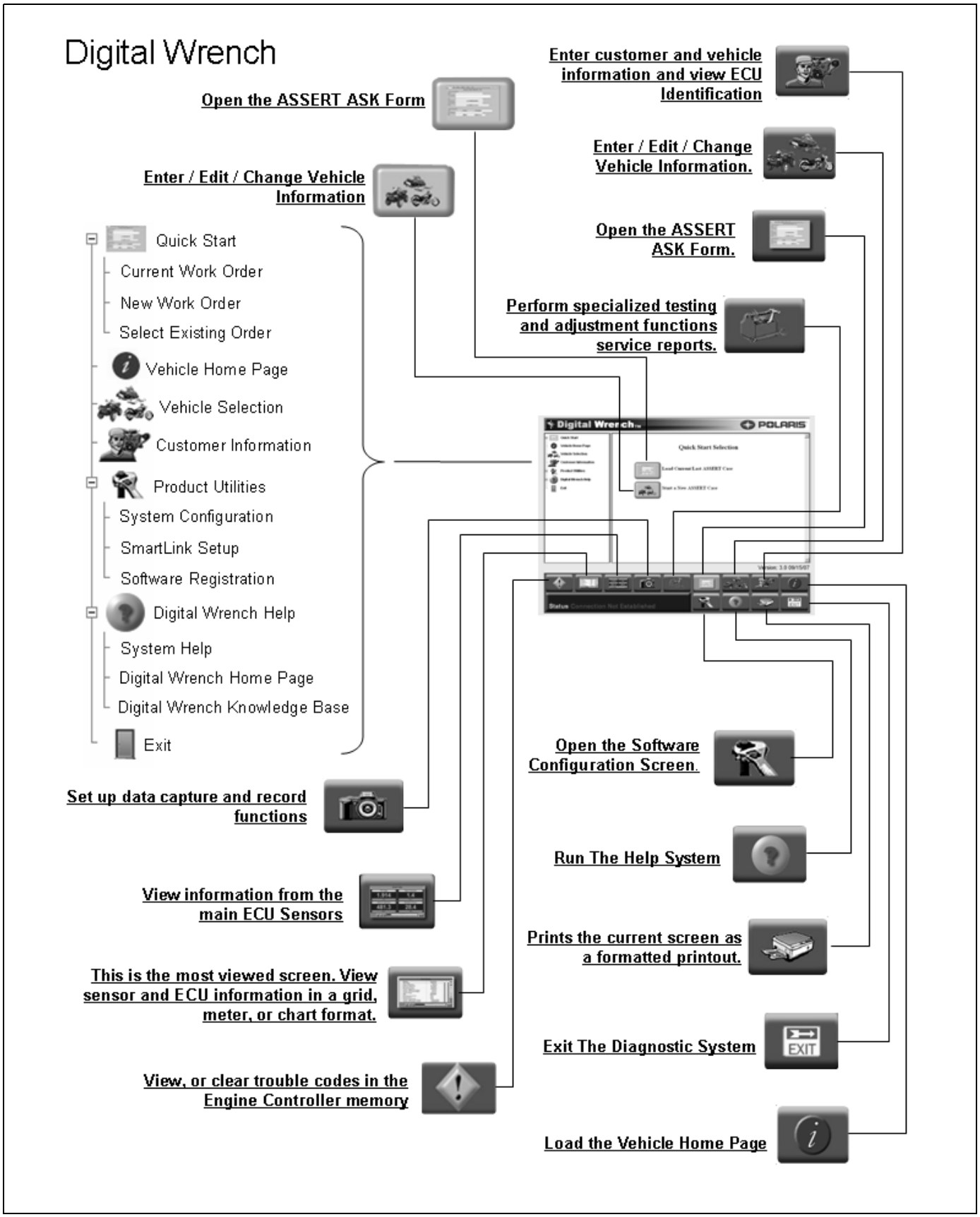
Digital Wrench™ Feature Map



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Engine Controller Reprogramming (Reflash)

Process Overview

The reprogramming feature is in the Special Tests menu on the Digital Wrench™ screen. Start Digital Wrench™ and click on the Special Tests menu icon (red tool box). A technician should be familiar with the process and with computer operation in general before attempting to reprogram an ECU.

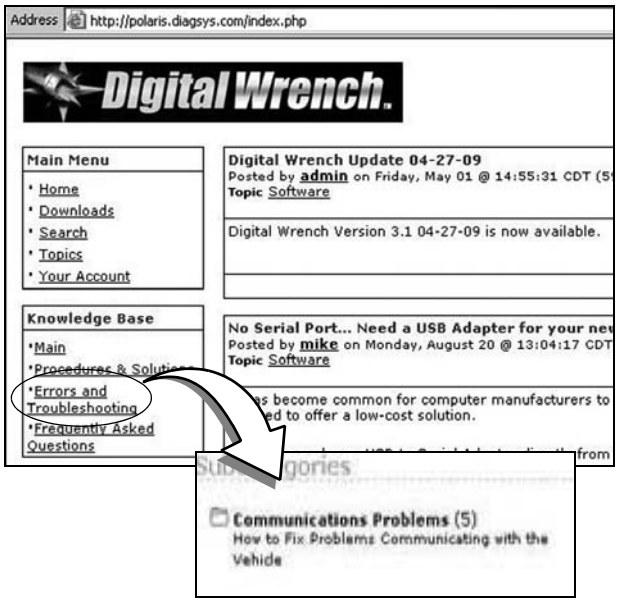
The Digital Wrench™ Engine Controller Reprogramming (or "Reflash") feature allows reprogramming of the ECU fuel and ignition map. To successfully reprogram the ECU, an Authorization Key must be obtained by entering a Request Code in the box provided on the Reflash Authorization site. The Request Code is automatically generated by Digital Wrench™ during the reprogramming process. The Reflash Authorization site is located under the "**Service and Warranty**" drop down menu on the dealer website at: ***www.polarisdealers.com***.

IMPORTANT: Failure to follow the reprogramming instructions completely and correctly can result in an engine that does not run! Replacement ECUs are programmed as "no-start" and require a reflash for them to work.

Reprogramming (Reflash) Tips:

- BATTERY VOLTAGE: The majority of problems with reprogramming can be attributed to a low battery. Be sure the battery voltage (no load) is at least 13 volts and at least 12.5 volts with the key 'ON'. Connect a battery charger if necessary to bring voltage level above minimum. Fully charge the battery before you attempt to reprogram.
- DEDICATED LAPTOP: Best results are obtained using a laptop computer that is "dedicated to Digital Wrench™". A laptop that is used by a variety of people and in several applications around the dealership is more likely to cause a reprogramming problem than one dedicated to Digital Wrench™ diagnostics only.
- OBTAINING THE LATEST UPDATE: Reprogramming updates are provided periodically and contain the most recent calibrations (see "Digital Wrench™ Updates").
- CLOSE NON-ESSENTIAL PROGRAMS: Polaris recommends that you DO NOT install non-essential programs on a Service Department laptop. Camera detection software, Virus Scanners, Tool Bars, etc. may clog up memory if running in the background and make it harder for the diagnostic software to operate.
- KNOW THE PROCESS: If you are not familiar with the entire reprogramming process, review the HELP section of the diagnostic software before you attempt reprogramming. Click on the **?** on the tool bar or press F11. The information in the on-line help is the most current and complete information available. This should be your first step until you are familiar with the process.
- COMMUNICATION PROBLEMS: If you have had problems communicating with a vehicle while performing diagnostic functions, do not attempt reprogramming until the cause has been identified and fixed. Check all connections, and be sure battery voltage is as specified.

  Proceed to ***http://polaris.diagsys.com*** for specific information and FAQs on how to troubleshoot communication problems.



- DON'T DISTURB THE PC: While reprogramming is in progress, don't move the mouse and don't touch the keyboard. The process only takes a few minutes, and is best left alone until complete.

Reprogramming (Reflash) Procedure:

If you are not familiar with the reprogramming process, review the "Reprogramming (Reflash) Tips" before you begin. Follow the on-screen instructions as you progress through the steps. If you encounter a problem, always check the On-Line help for current tips and information.

1. Verify the most current update has been downloaded and loaded into Digital Wrench™. See "Digital Wrench™ Version and Update ID" on page 4.35.

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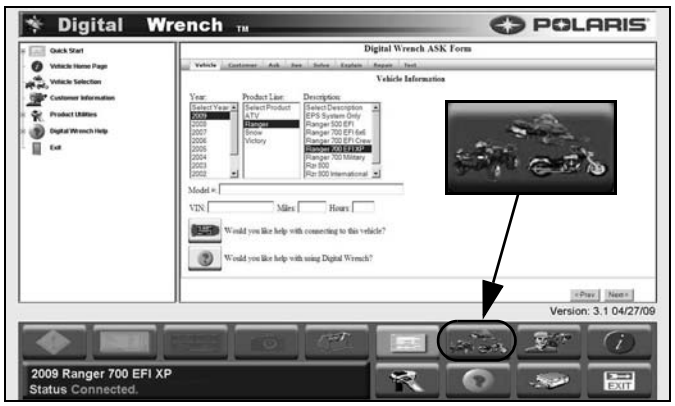
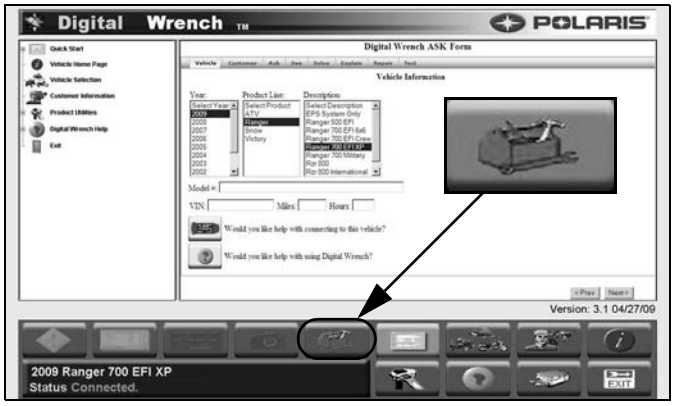
2. Connect the SmartLink Module cables to the PC and vehicle. See “Digital Wrench™ - Diagnostic Connector” on page 4.35.

3. Open the Digital Wrench™ program.

4. Select the model year, product line and vehicle description by selecting the “Change Vehicle Type” icon.

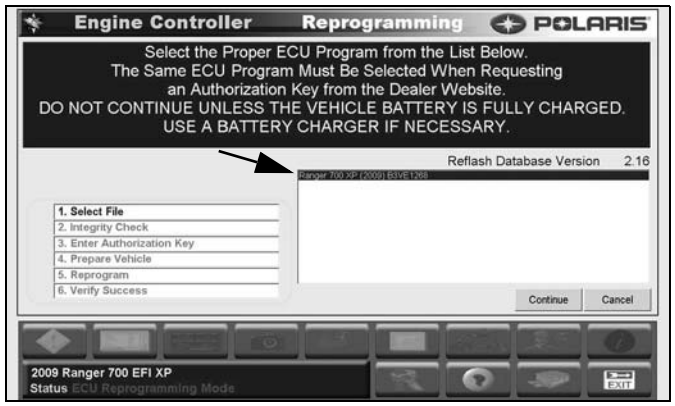


5. Select the “Special Tests” icon.

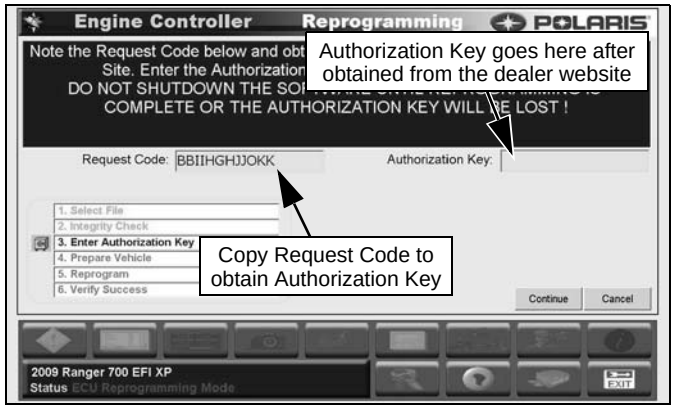


6. Select “Engine Controller Reprogramming”.

7. Select the file you want to load into the ECU then click the “Continue” icon to proceed to the Integrity Check and obtain a Request Code.



8. Copy (CTRL+C) the Request Code that will be required on the dealer website in the next step. DO NOT CLOSE Digital Wrench™ or the Request Code will be invalid. **NOTE: All characters are letters; there are no numbers in a request code.**



NOTE: Request Codes and Authorization Keys must be entered EXACTLY as they appear on the screen.

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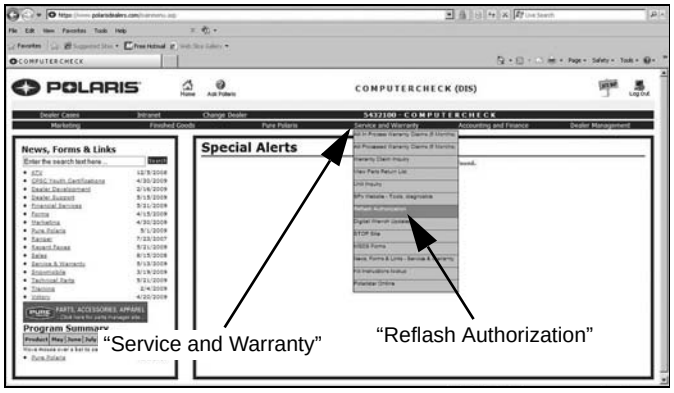
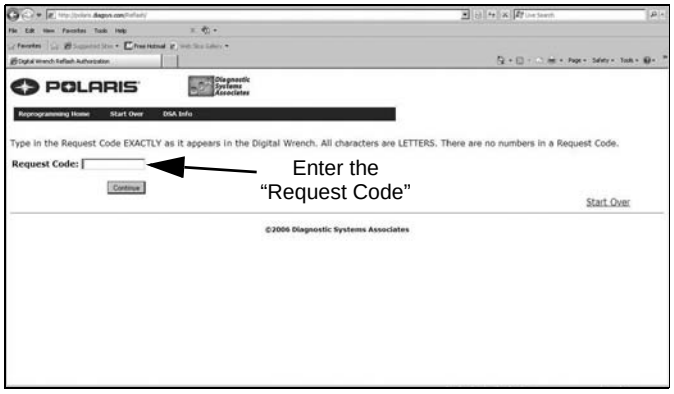
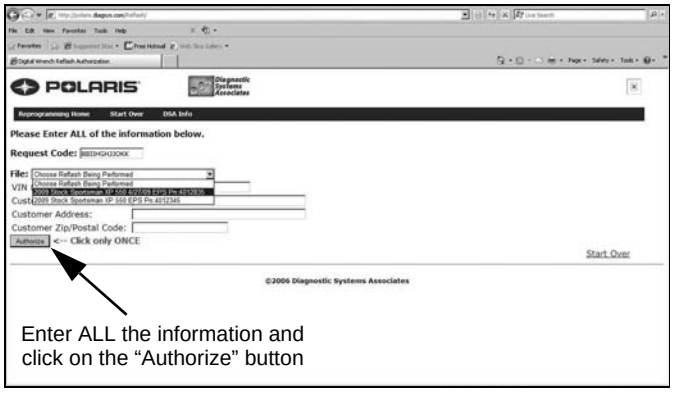
9. Go to ***www.polarisdealers.com*** and click on "ReFlash Authorization" from the "Service and Warranty" drop-down menu.



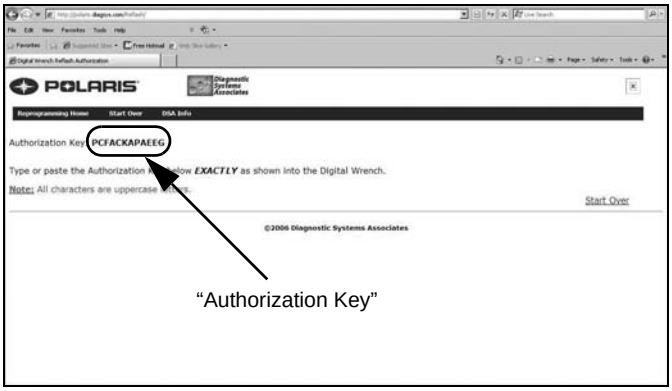
10. Enter or paste (CTRL+V) the Request Code into the box.



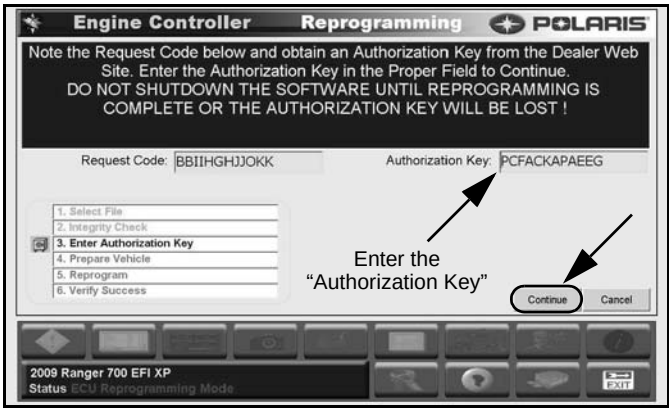
11. Select the same file type from the list that you selected previously while in Digital Wrench™. Enter the VIN along with the customer's name and address. When completed, click the Authorize button **<u>once</u>** to proceed.



12. An "Authorization Key" will appear in the upper left corner of the screen. Copy (CTRL+C) this key exactly as it appears.



13. Enter or paste (CTRL+V) the Authorization Key in the box located on the Digital Wrench™ screen. Click the 'Continue' button and follow instructions provided to complete the reprogramming procedure.



14. At this point the reflash process will begin. Do not touch the vehicle or PC during the process.

15. Once the ECU reprogramming procedure is complete, click the 'Finish' button on the screen. Verify the reflash was a success by starting the vehicle.

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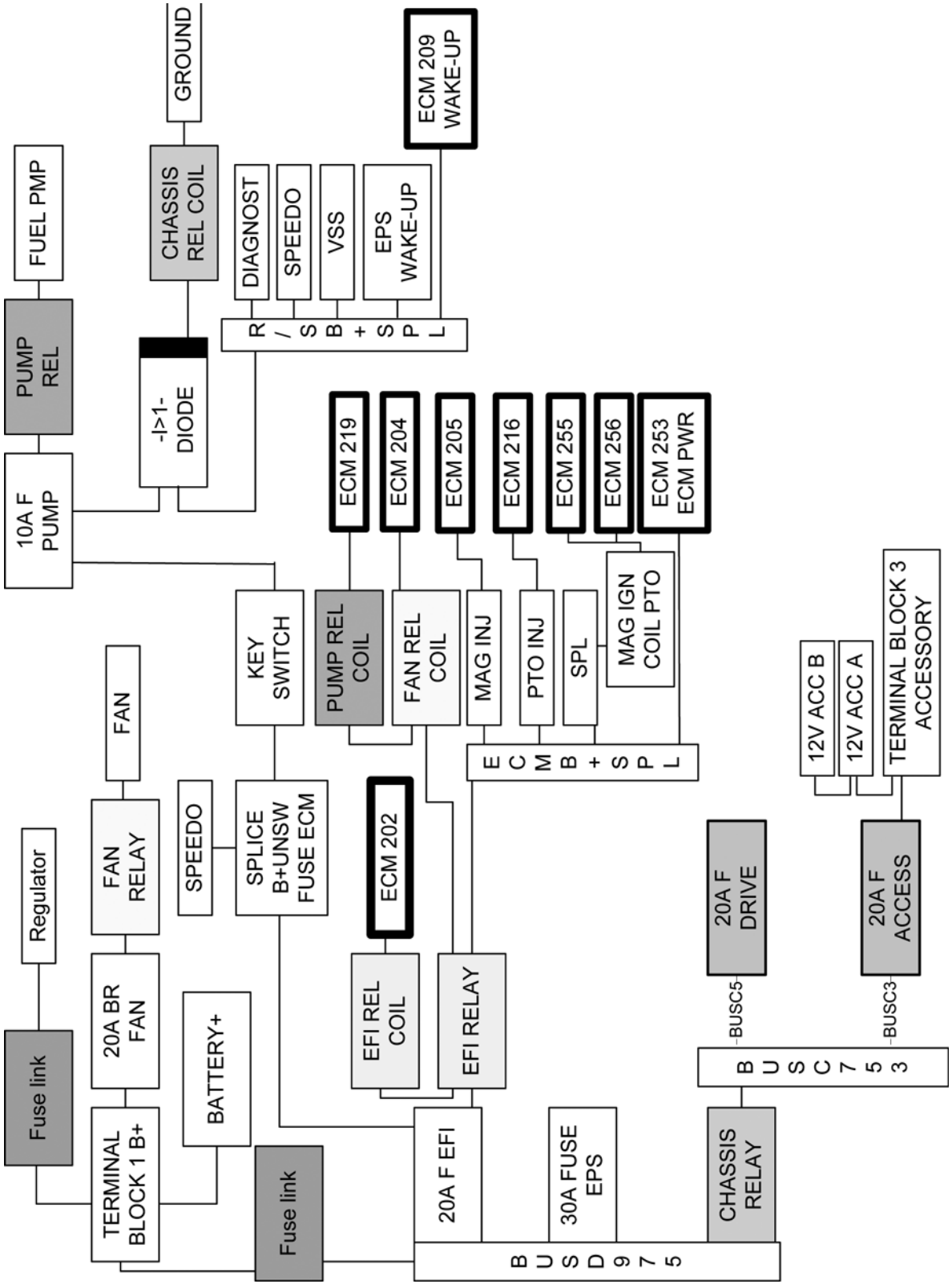
EFI SYSTEM ELECTRICAL OPERATION

Block Diagram



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NOTES

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